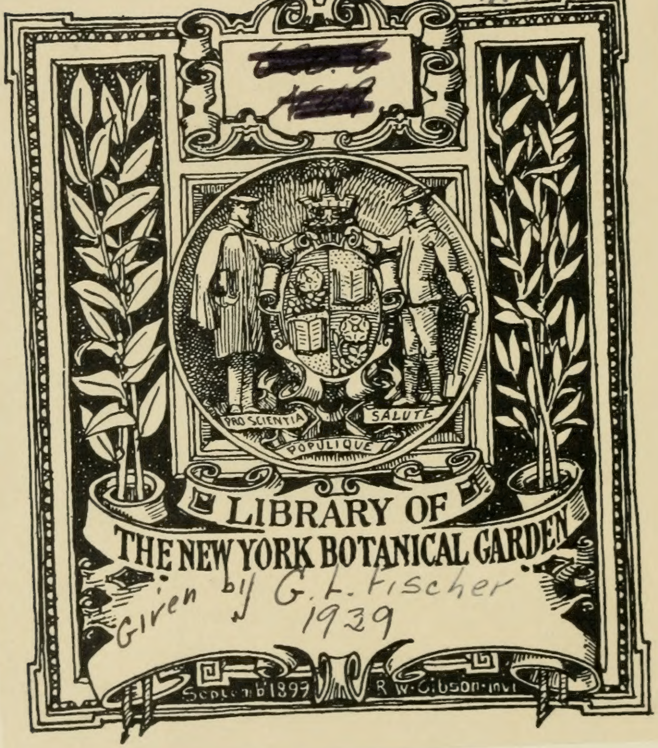
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TWENTIETH ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

Agricultural Experiment Station

ITHACA, N. Y.

1907

TRANSMITTED TO THE LEGISLATURE, JANUARY 15, 1908

ALBANY
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STATE OF NEW YORK.

No. 29.

IN ASSEMBLY,

JANUARY 15, 1908.

TWENTIETH ANNUAL REPORT

OF THE

Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January* 15, 1908.

To the Honorable the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to transmit herewith the Twentieth Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES E. WIETING,

Commissioner of Agriculture.

ORGANIZATION

Of The Cornell University Agricultural Experiment Station.

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

November 30, 1907.

The Governor of the State of New York, Albany, N. Y.,
The Secretary of the Treasury, Washington, D. C.,
The Secretary of Agriculture, Washington, D. C.,
The Commissioner of Agriculture, Albany, N. Y.:

The Act of Congress, approved March 2, 1887, establishing Agricultural Experiment Stations in connection with the Land Grant Colleges, contains the following provision: "It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the governor of the state or territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the Commissioner of Agriculture, and to the Secretary of the Treasury of the United States."

And the Act of the Legislature of the State of New York, approved April 12, 1906, providing for the administration of the New York State College of Agriculture at Cornell University, contains the following provision: "The said University shall expend such moneys and use of such property of the State in administering said College of Agriculture as above provided, and shall report to the Commissioner of Agriculture in each year on or before the first day of December, a detailed statement of such expenditures and of the general operations of the said College of Agriculture for the year ending the thirtieth day of September then next preceding."

In conformity with these mandates I have the honor to submit on behalf of Cornell University the following report.

My plan is to give first a general picture of the agricultural situation in New York State, and then to add a condensed statement of what is being done by the New York State College of Agriculture and the Federal Experiment Station at Cornell University. These outlines are followed by the more detailed statements contained in the report of the Director of the College, and his report is in turn supplemented by additional reports by the heads of some of the larger departments of the college.

The census for 1900 showed that there were in round numbers 227,000 farms in the State of New York. The value of the farm property of the State was $1,069,723,895, and the value of the annual farm products was $245,270,600, in both of which New York is surpassed by Illinois, Iowa, and Ohio. The value of the flocks

and herds of New York State is $139,514,947: $60,007,605 for horses, $387,253 for mules, $54,607,281 for milch cows, $14,855,158 for other cattle, $4,009,525 for sheep, and $5,648,125 for swine. The State has also 67,457 dairy farms or about one-sixth of all in the entire Union. The milk produced in 1899 (the last year for which figures are available) was 772,799,352 gallons. Of this amount 445,427,888 gallons were sold and $36,248,833 received therefor. New York ranks first among the states in the annual production of milk and butter and second in the production of cheese, the total value of all dairy produce in 1899 being $55,474,155. New York also ranks first in the number of dairy cows (1,501,608), and in the annual production of hay and forage ($55,237,446), vegetables ($25,756,000), forest products ($7,671,000), flowers and plants ($2,878,000), small fruits ($2,538,000), beans ($2,472,000), nursery products ($1,703,000), and hops ($1,600,000).

But there is another side to the picture. Up to 1870 New York held first place among the states in the value of its farm property. But in 1880 it was surpassed by Ohio, in 1890 by both Ohio and Illinois, and in 1900 by Ohio, Illinois, and Iowa. In population too there has been a decline in the rural counties owing partly to a lower birth rate but mainly to migration of the population to the cities and other regions. Still there were 1,200 more farm families in the State in 1900 than in 1890. But the families who owned their farms had decreased by 3,479 and the families hiring farms had increased by 3,238; so that the percentage of farms worked by owners had decreased in the decade from 79.8 to 74.4 and the percentage worked by tenants had increased from 20.2 to 23.9. Furthermore one-third of the 227,000 farms in the State were in 1900 reported as encumbered. Finally, there was between 1880 and 1900 an annual decrease in the value of farm property of $7,330,000.

In the interpretation of the figures which have been given certain fundamental facts must be kept in mind. First of all, agriculture in New York and generally in the east is in the process of adaptation to new conditions, in the course of which some farms have been abandoned and others enlarged, as in the keen competition some farmers have increased in prosperity and others have retrograded. Secondly, the land in New York is still productive, as is clear from the fact that, while in farm acreage it ranks seventeenth among the states (only 69% of the total acreage of New York being improved land), in the value of farm property it ranks fourth, or, again, that, though in the total value of its farm crops it is surpassed by Illinois, Iowa, Texas, and Ohio, in the value per acre of farm products it

surpasses them, the figures being for New York $15.73 per acre, for Ohio $13.36, Illinois $12.48, Texas $12.25, Iowa $12.22. Thirdly, the great and unparalleled markets of the State of New York are better than ever they were. Fourthly, experience is already showing that an intelligent study of the demands of the market and an intelligent diversification of agricultural enterprise—with due regard to the condition of the soil and the competition of the western prairies as well as the needs of the local market—offer a road to prosperity to the farmers of New York.

After all allowance is made for adverse factors, the objective conditions are still favorable for successful farming in New York. And with industry and energy, which are the gifts of nature or the products of family training, and with intelligence, which it is the function of education to stimulate and augment, the farmers of New York State may face the future with assured hope and confidence of successful results. What else do men need to achieve success but opportunity, personal energy, and knowledge which is power?

It will be seen, therefore, that for the successful adjustment of the agriculture of this State to new conditions, and for its prosperous development, the outstanding need at the present time is of greater knowledge and intelligence. The farmers must have their ways illuminated by the torch of Science. Farming was an easy, rule of thumb business in former times. But with all the world in competition, and with the multifarious demands of modern civilization, farming is a more complex and difficult job and calls for greater ability and higher intelligence. Modern universities, accordingly, give agriculture a place side by side with the learned and technical professions and vocations. And why not? In what calling can science make a man's work more fruitful? And are any other objects more worthy of study than those with which the farmer deals? If it is worth while analyzing gases, it is surely worth while analyzing soils; if men study bacteria and insects and flowers, why should they not give equal attention to horses and cows and fruit and grains?

The importance of superior education and scientific method for farmers is now generally recognized throughout the United States and even in an old, conservative country like England. The London *Times* concludes its editorial in its issue of September 10th with the following paragraph:

"To one very important condition of success both advocates and opponents of *la petite culture* in England pay, we suspect, too little regard—namely, the improvement of agricultural education, for the heads as well as for the rank and file of the industry. In too many of our country districts it is hardly

yet realized that education is necessary at all. It is not undue treatment in freight charges, or unpatriotic preference for foreign goods, that enables the small Danish butter-farmer, for instance, to undersell the Englishman on his own markets, but superior education and scientific method applied to the organization of his industry; and we may be sure of this, that it will be useless to keep a man on the land, or to bring him back to it, by the inducement of ownership or any other attraction, unless we can educate him to do the best for himself and for the land, in an age which calls for cultivated intelligence and scientific method."

This has always been the position of Cornell University. And the State has happily adopted the policy of co-operation with the University which the President outlined in his inaugural address. By virtue of that policy the University now has State Colleges of Agriculture and Veterinary Medicine which are domiciled in buildings erected by the State at a cost of over $400,000, and which the State supports with regular annual appropriations now aggregating $180,000, besides additional grants this year of $75,000 for special objects. The administration of these State colleges is a great responsibility for the University; and trustees and faculty are striving to execute the trust not only faithfully, but with the utmost wisdom, devotion, and enthusiasm. That they enjoy the confidence of the highest authorities of the State is happily evidenced by the language with which Governor Hughes closed his notable and appreciative address at the dedication of the new buildings for the College of Agriculture:

"On behalf of the State of New York, it is now my privilege and my agreeable duty to commit through you [President Schurman] to Cornell University the custody and control of these buildings and property, constructed and set apart by the State for the New York State College of Agriculture, and through you to commit to Cornell University the administration of this college for the benefit of the people of the State. And in doing this I take pleasure in expressing my confidence in the administration of this trust by Cornell University and my expectation that through this foundation the agricultural interests of the State will be notably advanced."

The service which Cornell University through these State Colleges renders to the farmers of the State is of a three-fold character. First it gives instruction in scientific agriculture and veterinary medicine to the students who come to the University to pursue those studies. Of these there were in 1906-1907, 86 in veterinary medicine, in agriculture 515 (of whom 244 were students in the Winter School). Secondly, it conducts investigations and experiments in the production of crops of all kinds, in the rearing and breeding of live stock, in the manufacture of dairy and other products, and in the diseases of farm plants and animals with a view to discovering

the most efficacious remedies and preventions. The chief investigations conducted during the year 1906-1907 by the Veterinary College were as follows:

In bacteriology and pathology important investigations on the agglutination method of diagnosing glanders, experiments to ascertain the best disposition of occult glanders, experiments on the Bang method of replacing tuberculous herds of cattle by sound ones raised from their own calves, investigations into the condition of the blood of animals suffering from particular diseases, investigations into the nature of a series of epizoötics of anthrax, investigations on the treatment of glanders with opsonins, and investigations into the causes and prevention of distemper in dogs: in materia medica investigations into the physiologic action of drugs upon the circulation of the horse and of the effect of specific drugs on the metabolism of the body, investigations of antidotes to certain poisons and research into the therapeutic action of drugs: in surgery the improvement and attesting of an operation for roaring in horses, and investigations in chloroform anaesthesia of the horse: in sanitary science experiments in the treatment of chronic glanders by means of the serum of a cow.

The main investigations conducted during the year 1906-1907 in the College of Agriculture were as follows:

In entomology the study of the joint worm of timothy grass, of the insect pests of rhododendrons, of the minor pests of ornamental shrubs, of the oyster-shell bark scale, of the life-history of the violet gall-fly in greenhouses, and its methods of treatment: in plant-breeding the breeding of various strains of timothy, brome grass selection, the development of different strains of mangels and rutabagas, the substitution of root crops for silage, root-crop production experiments, studies of vetch, clover, and alfalfa: in animal husbandry beef production in New York State and the use of skimmed milk for the production of pork: in agronomy factors that influence the growth of clover, alfalfa and peas, an alfalfa survey to determine where alfalfa will grow and how best to grow it, investigations of the hairy vetch to determine what place this plant will occupy in New York agriculture, and the influence of fertilizers on the yield and quality of timothy hay: in horticulture investigations of the little peach disease, black rot of grapes and diseases of beans, and an orchard survey of Niagara County: in poultry husbandry experiments on the fertility of eggs and fowls and the feeding and breeding of poultry: in plant pathology various investigations into the diseases of plants, especially of grapes: in dairying experiments on the manufacture of milk products, the making of sanitary milk and questions involved in the handling of market milk: in soil investigations research into fundamental questions in regard to soil fertility, the adaptation of crops to particular soils, special methods of soil treatment, and a soil survey of Niagara County.

Thirdly, by means of lectures, correspondence, and printed lessons and bulletins, it diffuses agricultural knowledge among the farmers of the State and their families and teachers in the schools. This extension work aims to help the farmers of the State to help themselves without ever leaving their farms.

The following figures show the extension work of the College of Agriculture during the year 1906-1907: number of readers in the farmers' reading course, 2,855; number of readers in the farmers' wives' reading course, 21,867; number of children in the junior naturalist clubs, 18,966; number of teachers in correspondence, 2,655; number of co-operative experiments, 517; number of experimenters, 300; number of experimental plats, 2,000; number of counties in which the experiments were carried on, 55; number of bulletins issued, 14.

The most memorable event of the year was the formal dedication of the new buildings for the State College of Agriculture, which was honored by the presence and inspired by the address of Governor Hughes. Impressive addresses were also made by ex-Governor Bachelder, Master of the National Grange, General Woodford, who represented the State at the opening of the University in 1868, and Professor L. H. Bailey, the Director of the College. Another very significant event was the unsolicited and unexpected donation to the University of $30,000 for the foundation of five scholarships in agriculture by Dr. Charles H. Roberts, of Oakes, Ulster County, New York, who by the aid of scholarships was in his youth enabled to pursue the study of medicine. These scholarships have been designated by the trustees "The Charles H. Roberts Scholarships."

Fuller details regarding the work, needs, and plans of the New York State College of Agriculture will be found in the following report of the Director of the College of Agriculture, which, as will be seen, is supplemented by reports from the heads of the larger departments of the College regarding the work falling especially under their charge.

The Legislature has generously voted appropriations for the establishment and maintenance of the New York State College of Agriculture. To it Cornell University also makes important contributions from its own treasury. The State has also charged Cornell University with the duty of administering the College. And the president and trustees of the University are, with the hearty and effective co-operation of the director and faculty of the College, bending every energy to bring technical knowledge and scientific method to the aid of the farmers, to cultivate an intelligent understanding of farming in all its phases, and to advance the general agricultural interests of the State.

Respectfully submitted,

J. G. SCHURMAN,

President of Cornell University.

REPORT OF THE DIRECTOR.

To the President of Cornell University:

Sir.—I submit herewith a summary report of the work of the New York State College of Agriculture for the year ended September 30, 1907. The year is signalized by the occupancy, near the close of the year, of the new buildings erected by the State, which are now nearly completed. The Animal Husbandry building is not yet occupied. The forthcoming college year will see the buildings all completed and the equipment installed; and the buildings and their contents will represent a total investment of about $400,000. These buildings house all the departments of the College except the Poultry Department, Agricultural Chemistry, and, for the time being at least, some of the work of the Rural Art. The poultry work is established in buildings not erected by the State and which are wholly inadequate for the important and growing work of the Department. The Agricultural Chemistry is established in Morse Hall, where it might properly remain if the facilities were ample; but, as a matter of fact, the room that is available is not sufficient to allow of much growth, and the question must soon be raised as to how this fundamental work is to be provided for. The Horticultural Department still does its glasshouse work in the old forcing houses, which are antiquated and now far removed from the main buildings. A set of modern glasshouses is now the most needed of any proposed buildings not already provided for; and I recommend that the incoming Legislature be apprised of this fact. The glasshouses are needed by the departments of Horticulture (including floriculture), Entomology, Plant Pathology, Nature-Study, and the various departments that are associated with the agronomical and plant-breeding groups.

The new buildings give every promise of being perfectly adapted to their work, and they are a source of much satisfaction to us all. The quarters of every department will be speedily outgrown, however, if the departments meet the demands that the agricultural interests are making. The buildings were dedicated April 27, 1907, by the Governor of the State. It is assumed that the State of New York, entering on the undertaking of establishing and maintaining a college of agriculture, desires to have an institution that will be thoroughly effective and in every way worthy of the State. It be-

comes the duty of Cornell University, therefore, as custodian of this enterprise, to acquaint the people and the Legislature with the additions that are needed from year to year to enable the college to serve the agricultural interests of the State. The responsibility of supplying such additions must rest with the people.

The additions to the staff during the year, aside from student assistants, are as follows:

Lyon, Thomas Lyttleton, B. S. A., Ph. D., Professor of Experimental Agronomy.

Fippin, Elmer Otterbein, B. S. in Agr., Assistant Professor of Agronomy with Reference to Soils.

Stocking, William Alonzo, Jr., B. Agr., B. S. A., Assistant Professor of Dairy Bacteriology.

Warren, George Frederick, B. Sc., B. S. A., M. S. A., Ph. D., Assistant Professor of Agronomy.

Judson, Lowell B., A. B., B. S., Assistant Professor of Horticulture.

Webber, Herbert John, B. A., M. A., Ph. D., Professor of Experimental Plant Biology.

Duggar, Benjamin Minge, M. S., Ph. D., Professor of Plant Physiology.

Crosby, Cyrus Richard, A. B., Assistant Entomologist in Experiment Station.

Ross, Harold Ellis, B. S. A., Assistant in Dairy Industry.

Coit, James Eliot, B. Agr., M. S. in Agr., Assistant in Horticulture.

Swaine, James Malcolm, B. S. A., M. A. S., Assistant in Economic Entomology.

Hedges, Charles Cleveland, B. S., Assistant in Chemistry in its Relations with Agriculture.

Van Auken, Charles Herbert, Assistant in Animal Husbandry.

Tuck, Charles Henry, A. B., Supervisor Farmers' Reading-Course.

Cook, Miss Margaret F., Assistant in Nature-Study.

Needham, James George, B. S., M. S., Ph. D., Assistant Professor of Limnology, jointly in the Colleges of Agriculture and of Arts and Science, to investigate and teach the subjects associated with aquatic life (particularly the forage of fishes).

Baker, William Charles, B. S. A., Assistant Professor of Drawing.

Norton, Jesse Baker, M. S., Assistant in Plant Biology.

White, Paul J., A. B., M. S. A., Instructor in Farm Crops.

Rose, Miss Flora, B. S., Lecturer in Home Economics.

Taylor, Albert Davis, M. S. A., Instructor in Rural Art.

Riley, Howard W., M. E., Instructor in Farm Mechanics.

At its June meeting, the Board of Trustees provided for seventy-three officers in the teaching and experimenting staff (aside from stenographers, janitors, helpers, and student assistants), with a salary roll of nearly $100,000.

The increase in students in the College of Agriculture has exceeded the capacity of the equipment and facilities at our disposal, inasmuch as we were not able to use any part of the new buildings for the entire college year, and large parts of them not at all. The total enrollment of students registered in the College of Agriculture, 1906-7, is as follows (being a total gain of 34 over the previous year):

Graduates	33
Regulars	145
Specials	129
Winter-course	241
	548
Counted twice	6
	542

The distribution of registration in the winter-courses is as follows:

General Agriculture	84
Dairying	74
Poultry Husbandry	47
Horticulture	12
Home Economics	24
	241

The year has witnessed the foundation of five scholarships in the College of Agriculture by Dr. Charles H. Roberts of Oakes, Ulster County, New York. The endowment of $30,000, on which these scholarships are founded, was given to the University without solicitation, the donor feeling that something should be done to aid the struggling country youth in the effort to secure an education that should prepare for country life. The gift is made in recognition of similar aid that the donor received in his youth that enabled him to pursue studies in the Albany Medical College. This noble gift is the first permanent endowment in this country, so far as I know, for scholarships in agriculture, and it is especially fitting that the name of the donor should be organically associated with it in the title "The Charles H. Roberts Scholarships." This gift is substantial recognition of the fact that agricultural education is now beginning to appeal to the general public.

In this connection, it may be recalled that eight scholarships are now provided by outside agencies in the winter-courses, as follows: six offered by the New York State Grange, of a value of $50 each; one by the Stafford Grange (Genesee county); one of $75, by Mr. Harrison L. Beatty, to a properly qualified student from the town of Bainbridge.

DEPARTMENTS OF WORK NOW REPRESENTED.

The following separate organizations or departments now comprise the State College of Agriculture: Farm Crops, Animal Husbandry, Poultry Husbandry, Dairy Husbandry, Horticulture, Farm Mechanics, Home Economics, representing the farm-practice or home-practice group; Soils, Plant Biology (plant-breeding), Plant Physiology, Plant Pathology, Entomology, Agricultural Chemistry, Rural Economy, Rural Art, Drawing, Meteorology, representing the underlying science and art group; Nature-Study, Reading-Courses, Extension Teaching, representing the outside or extension group. The winter-courses are not organized as a separate entity, but comprise part of the extension work of the various departments.

Some of these departments represent the old Department of Agronomy, which has now been divided into its natural units. Colleges of agriculture tend to over-organization, to the development of such large and complex departments that a good part of the time of one or more specialists must be given to mere executive work. In the interest of good teaching and real efficiency in research, the specialist should have only such administrative duties as pertain to his specialty. The best teaching and experimenting is personal, and cannot be delegated to subordinates. Agronomy is not a unit or a specialty. We have separated the old department of that name into several, all the units being co-ordinate and each in charge of a specialist. The farms have been made a separate unit or department, in charge of the Professor of Farm Practice, thereby putting the farms into equal relationship with every other department of the college, and allowing every department to have equal opportunity to utilize them for purposes of instruction.

In the above list of departments, special attention should be called to two that are now first organized or separated. These are Farm Mechanics and Home Economics.

The Farm Mechanics Department deals with the whole question of developing the mechanical sense in farm students, a line of effort that has heretofore received comparatively little attention. The use of machinery has now come to be a permanent part of the equipment for good agriculture, and the kinds of machines are legion.

The principles that are involved in farm machinery, and the practice, cannot be adequately discussed in most colleges of mechanic arts or engineering, for such colleges have another and special point of view. Several of the colleges of agriculture are now developing departments of farm machinery. The subject needs emphasis in the east as well as in the west. In fact, it needs greater emphasis here; machinery has been developed mostly for easy conditions and large areas; it now needs to be developed for the more difficult and complex eastern conditions. Every farm should be provided with a shop, and the farmer should understand the use of tools and the principles that underlie the operation of machinery. Our Farm Mechanics Department is now housed in the basement of the Agronomy building, in quarters which it will outgrow this coming year. It should be one of the largest departments in the college.

Home Economics work designs to do for the farm woman what other departments do for the farm men. The department was established by action of the board of trustees in June, 1907, although winter-course work in these subjects had been given for two years. The object of this department is to provide courses of instruction in those branches which best serve the interests of women students and to furnish a basis for the practical correlation of chemistry, and the physical, biological and social sciences with Home Economics. Laboratory facilities are being provided, together with other modern equipment. The courses to be given in this department are designed to meet the needs of three classes of students:

1. Academic work given as a regular part of the course leading to the degree of Bachelor of Science in Agriculture.

2. Classes open to other students who desire only a general knowledge of the principles and practice of Home Economics.

3. A winter-course, requiring less previous preparation on the part of the student, is open to those desiring brief practical training in Home Economics.

OTHER DEPARTMENTS NOW NEEDED.

It should be the first purpose of the college to develop the departments already established. None of them has yet reached its full stature. Other lines of work must be established, however, if the college is to be able to serve the State to the greatest advantage. Some of these may now be mentioned.

Normal Department.—The greatest need in pedagogy at present is the necessity of relating rural education to the lives and affairs

of the people. It is devolving largely on the agricultural colleges to revive and redirect the rural school in its agricultural relations. One of the greatest obstacles to the progress of this effort is the almost total lack of teachers who have neither any knowledge of the needs of the people or any outlook to the work. There is great danger that the present interest in agricultural education may collapse, as similar but smaller previous movements have collapsed, unless a very active effort is made to train teachers for the work. These teachers must be trained in agricultural colleges. At Cornell, we already have the beginning for the training of such teachers in our two-year nature-study course, and the rural school-house and gardens that are now established as a part of our work. We have taken part in the propaganda for better and more significant rural schools. I would organize this proposed normal work by adding at once two or three persons to our staff to handle the general subjects and to prosecute the large extension work that should go with the enterprise; and then arrange for the giving of adaptable technical instruction in the various specific subjects by the regular departments in the college. In this way we could quickly organize and assemble a very strong department for the training of persons to teach nature-study, elementary agriculture and related subjects. Herein, it seems to me, lies the greatest opportunity to serve the interests of the agricultural country.

Farm Forestry.—The forests are important sources of wealth and prosperity in New York State. There are great tracts of public forests. Almost any farm of any size also has its forest. About one-third of New York is in woodland. In the last census year, New York led all the states in the Union in the value of farm forest products. These forests are related also to maintenance of streams, water power, water supplies, floods, fish and game, climate and the general attractiveness of the country. No institution in the State is teaching forestry. The State is greatly in need of an enlightened intelligence on these questions. They are primarily agricultural questions. The forest is a crop. This college of agriculture is giving advice on many crops of much less importance than the forest crop. I recommend that forestry work be established in the College of Agriculture. We have some forest on the University farm, with which to begin, as a laboratory. Land could be purchased in this part of the State on which to establish a commercial forest. We should then be in a position to aid the State, in case our services were desired, in the State forests. In fact, I anticipate that the State forests could be made, in a very important sense, laboratories and trial grounds for such department, the work

always being done, however, under the administration of the regular state commission provided for the care of the forests. Such work ought to grow in importance year by year, rendering direct service both to the farmers and to the State government. It should be able to meet the economic needs of the people, to provide one more agency to educate persons in terms of their daily lives, and also to train professional foresters.

Rural Engineering.—Under this term was included such field engineering problems as have to do specially with agricultural enterprises, as surveying with reference to land measure, drainage, irrigation, road-making, water-supplies, and many of the lesser problems of bridge-building, traction development, and other construction. Nearly all the land of the open country is to be in farms (using the word farm to include organized and managed forests), and the complete utilization of this land will demand the expenditure of much engineering skill. The engineer will probably contribute as much as any other man to the making of the ideal country-life. Professional engineering problems must be left to the technical engineering schools; but training must also be provided from the agricultural point of view and in connection with other agricultural studies. These agricultural engineering subjects are bound to multiply. Irrigation, for example, is not to be confined to arid regions; it must be added to humid regions not only to overcome the effect of drought but to cause the land to produce to its utmost. Irrigation for humid climates presents a special set of problems, for it must be intimately associated with drainage, and these problems are not yet thoroughly understood. The problem of efficient highways needs very much to be considered. This is primarily an agricultural problem, because these roads should be made to serve country necessities rather than urban necessities. It has relation not only to transportation, but to valuation to farm property and to the developing of the economic and social phases in general. The highway commissioners, or other local officers, are farmers or closely associated with farmers; they should be given opportunity in a short-course to receive practical instruction in road-making. The effectiveness of the road work of the State will be determined very largely by the training of the men who have the work in charge in the different localities, or who make public sentiment in those localities.

Rural Architecture.—Rural architecture is, for the most part, hopelessly inefficient and therefore hopelessly inartistic. Real farm architecture will not be handled by professional architects because there are no fees in it; and, as in the case of rural art in general,

the public sense must be quickened. Moreover, the problems in farm architecture are essentially agricultural problems. This is particularly true of barns and stables. Practically all barn buildings must be rebuilt on fundamentally new lines if farming is to be an efficient business. In the past, barns and stables have been built merely to house and protect produce and animals, rather than to accomplish certain definite progressive ends. The modern ideas of sanitation, whereby dust is to be eliminated, are revolutionizing stable construction, to say nothing of the means of securing cleanliness in other ways, of ventilation, of sunlight, water-supplies, and other necessities. Probably the best ventilated buildings now constructed are the modern cow-stables.

Extension Work.—Although extension work of this College of Agriculture has been a conspicuous feature for many years, there is nevertheless great need for its enlargement. A college of agriculture cannot confine its work to the persons who come to its laboratories and class rooms; it must reach every person on the land. There should be a thorough-going system of visitation of farms for the purpose of giving advice when asked for, and to aid the farmer in acquiring the most recent information and point of view. The agricultural condition of every community and of the State should be thoroughly known to the agricultural college; and in order that this condition may be understood it is necessary that agricultural surveys be made. These surveys should have for their object the determining of all the conditions that go to make up failure and success in farming, and to enable the college to draw general conclusions for the betterment of the agricultural condition. For many years this College of Agriculture has undertaken surveys of one kind or another, mostly in horticultural subjects. Many years ago a survey was made of the condition of the peach industry in the State; others of the condition of plum-growing and quince-growing; and more recently very thorough pomological surveys have been made of some of the counties, and this type of survey is still in progress. The college is now making a thorough study or survey of the agricultural conditions in Tompkins county, preparatory to extending a similar inquiry, if funds are available, to all parts of the State. It is the purpose to inspect every farm in the county, and to secure first-hand information in regard to its productiveness, methods employed, and the general conditions that make for success or failure. This survey has been under way for two years, and nine hundred and fifty farms have been carefully inspected. The following tabular statement indicates the general nature of the inquiry:

9707

No........Page 1

The New York State College of Agriculture

Cornell University, Ithaca, N. Y.

Date.. ....

Location of Farm..

Owner..(........) yrs........P. O. Address..............................Age............

Tenant..(........) P. O. Address..............................Age............

How long has present tenant operated farm?........................cash rent ....share rent........................

What does tenant furnish?..

If the farm is operated by a tenant what is the occupation of owner?..

Total area of farm..............................Value per acre............................No. acres tillable............................

Acres in timber..............................Waste land, including roads, streams, etc..............................

What is the character of the soil?..

Is the farm well drained?..

What are the chief products sold?..

9707

FARM CROPS DURING 1906.

No.......Page 2

Kind.	Quantities Produced.		Amount Sold.	Value of Products.		Remarks.
	Per Acre.	Total.		Per. bu. or ton.	Total.	
Corn for grain						
Corn for fodder						
Wheat						
Oats						
Barley						
Rye						
Rye straw						
Buckwheat						
Hay						
Potatoes						
Beans						
Apples						

9707

FARM ANIMALS—NUMBER AND VALUE DURING 1906.

No.........Page 3

ANIMALS.	Number April 1, 1906.	Value.	Number Sold.	Price.	Number Bought.	Price.	Number Raised.	Number April 1, 1907.
Calves								
Heifers								
Steers								
Bulls								
Cows—for milk								
Cows—not for milk								
Colts								
Horses								
Sheep								
Lambs								
Poultry								
Brood Sows								

ANIMAL PRODUCTS SOLD DURING 1906.

Products.	Amount.	Value.	Products.	Amount.	Value.
Butter			Wool		
Milk			Pork		
Eggs					

9707

THE ESTIMATED VALUE OF CAPITAL, APRIL 1ST, 1907.

No.........Page 4

Real Estate........................	....	....
Machinery and tools........................	....	....
Farm Teams........................	....	....
Other live stock........................	....	....
Grain and other feed........................	....	....
Total........................	....	....
EXPENDITURES FOR 1906.		
Labor (actually paid)........................	....	....
Board of paid laborers, estimated........................	....	....
Labor by male members of family not paid for........................Ages........................	....	....
Seeds—clover, timothy, etc........................	....	....
Feed........................	....	....
Fertilizers........................	....	....
Machinery........................	....	....
Buildings and Fences........................	....	....
Live Stock........................	....	....
Miscellaneous, as horse shoeing........................ thrashing, repairs, etc........................	....	....
Total........................	....	....

GENERAL QUESTIONS.

Has the farm increased or decreased in value during the past five years?........................

How long have you lived in this community? .... Has the soil increased or decreased in fertility during.........yrs?........................

Do you receive bulletins from Cornell University? ....

Pure bred animals: kinds........................ ....Number........................

Most profitable kind of animal products........................

Are sheep kept for winter or spring lambs?........................

Do you raise your own cows..?........................

Do you use a pure bred bull?........................

Have you a special market for poultry products? ....

....

....

....

GENERAL NOTES BY OBSERVER.

No.........Page 5

1. What system of rotation is followed?..........

2. Are farm buildings in good repair?..........

3. Are fences in good repair?..........

4. Does the farm give you an impression of prosperity?..........

5. What is the condition of public and private roads?..........

6. Sanitary condition of farmstead..........

7. Sanitary condition of dairy stables..........

8. What is the degree of completeness of these answers?..........

9. What suggestions for improvement would you make?..........

....

....

....

....

....

....

....

....

Recorded by..........

SPECIAL FOR CAROLINE TOWNSHIP. No.........Page 6

What variety of clover is preferred by the farmer?..........

Are there any difficulties in the way of growing clover?..........

Name them..........

....

Is there a good stand of clover in this year's seeding?..........

How is the stable manure cared for and used?..........

....

What weeds are most plentiful in the meadows?..........

....

Are there any vacant farmhouses in this neighborhood?..........

Why are they unoccupied at present?..........

How many acres in the farm with the unoccupied house?..........

How long has the house been unoccupied?..........

....

....

....

9933

I consider that a thorough-going inquiry of this kind gradually extended to all parts of New York State is of the very greatest importance. It would give to the State first-hand data gathered by experts as to the actual condition of our agricultural industries, and would be the foundation for the making of careful studies as to how our agriculture can best be adapted to its local conditions. This inquiry should be followed up or correlated with a study of the social and economic condition to the end that the whole status may be thoroughly understood. A survey of this kind would require the expenditure each year of a few thousand dollars; and it should be spent only as rapidly as thoroughly trained men can be found to undertake the work, and as the results can be carefully studied and digested.

THE EXPERIMENT STATION.

With the pressure of teaching and administration, the work of the man who is engaged in experiment or research is likely to be very much broken. Fruitful research requires that a man be able to give the subject his major attention consecutively for a sufficient period of time to carry the work to a finish. In order that there may be the least possible interference with such work, the funds received from the Federal government under the Hatch Act and the Adams Act have been set aside for the maintenance of research work. The temptation to start many lines of work and to employ many men has hindered rather than encouraged investigation. It is therefore conceived that it is better to maintain two or three departments from the Federal funds, and to maintain each one strongly, than to establish many enterprises no one of which could have sufficient funds to enable it to develop its best results. Leaving aside for the time being live-stock interest (certain phases of which are already handled by the Veterinary College), it is conceived that the remaining biological and chemical problems of agriculture associate themselves about two points, namely, the soil and the plant. We have, therefore, organized on the Federal funds a department of soil inquiry with Dr. Lyon at its head, and a department of plant biology (which will be largely given to plant-breeding) in charge of Dr. Webber. The only other department that receives any maintenance from the Federal fund is the entomological work in which one man is supported from these sources. The men who are employed on the Federal funds expected to give all their time to research. They teach no undergraduate students, but they may take a limited number of post-graduates, who will become practically assistants in the investigational work. For the work of

these two departments two small greenhouses are now being erected and will be ready for occupancy this coming winter.

While the above persons are expected to devote their time to research, it does not follow that all others in the college are devoting themselves wholly to teaching. In fact no person can be a good teacher in the natural sciences who is not at the same time an investigator. While all the other officers of the college are expected to devote their first efforts to teaching it is also presumed that every one of them will be conducting investigations, and the results of these investigations as they mature will be published as bulletins. These men are members of the Experiment Station but none of them receives any part of his salary from the Federal Experiment Station funds, nor are such funds appropriated for the maintenance of his department.

DEPARTMENTAL REPORTS.

The main features of the work of the larger departments in the college, for the year ending September 30, 1907, are submitted herewith. Other departments are yet in their development stage, and will need full consideration in future reports. Although this college is now liberally supported by the State, every department sees opportunities to serve the State far in advance of facilities and maintenance now available; and it should be understood that whatever additional facilities may from time to time be requested of the Legislature are not demanded for the benefit of an institution but only that the institution may meet the obligations required of it by the people and thereby increase the agricultural effectiveness of the commonwealth.

Respectfully submitted,

L. H. BAILEY,

Director New York State College of Agriculture.

Statement of expenditures, fiscal year 1906-1907, under State appropriation for the promotion of agricultural knowledge throughout of the State and for the maintenance, equipment and necessary material to conduct the New York State College of Agriculture.

	September 30, 1907.
Agronomy	$7,105 84
Agricultural Chemistry	796 05
Animal Husbandry	572 65
Botany	382 64
Entomology	495 43
Dairy Industry	5,500 00
Junior Naturalist	1,809 93
Horticulture	3,303 50
Salaries	47,738 93
Nature-Study	990 07
Home Nature-Study	1,104 91
Poultry Husbandry	2,511 30
Office Administration	11,382 47
Equipment	10,000 00
Reading-Course for Farmers	1,005 39
Reading-Course for Farmers' Wives	1,122 07
Balance to complete purchases and expenditures contracted for but not yet yet completed so that actual payment could be made	4,178 82
	$100,000 00

AGRONOMY.

The following report concerns the operations of the Department of Agronomy for the Federal year ended June 30, 1907 (near the period when Professor Hunt severed his connection with Cornell University).

I. Teaching Work.

The courses of study and the numbers of students pursuing them in the Department of Agronomy during the year 1906-7 have been as follows:

Agronomy 1, first term	93
Agronomy 3, first term	6
Agronomy 4, second term	23
Agronomy 5, throughout the year	9
Agronomy 11, first term	58
Agronomy 111, second term	33
Agronomy 12, second term	61
Agronomy 13, first term	12
Agronomy 14, second term	14
Agronomy 15, first term	13
Agronomy 15, second term	15
Agronomy 16, first term	12
Agronomy 19, first term	15
Agronomy 19, second term	12
Farm Machinery 52, second term	65
Agronomy, Winter-Course students	81
Post-Graduates, first term (in residence)	9
Post-Graduates, second term (in residence)	7

The repetition of course 11 given in the first term as course 111 in the second term has been found a satisfactory arrangement. It has reduced the number of students in each term, has kept the facilities for this work in use throughout the year and has enabled a modification of the instruction to meet the needs of the different groups of students. Without such division the facilities of the department would have been greatly overburdened. Attention is called to the fact that instruction should be offered in agronomy 12, first term, for students who took agronomy 111, second term, this year. Next year, agronomy 101 will be offered in the first term in place of agronomy 1, and agronomy 1 will be given in the second term. This is done with the understanding that agricultural chem-

istry will be taught to sophomores in the first instead of the second term. Agronomy 16, tropical agriculture, was this year offered as a separate course of study for the first term.

During December, Dr. Jacob G. Lipman, Chemist and Bacteriologist at the New Jersey Agricultural Experiment Station, delivered ten lectures, conducted two seminars and eight laboratory periods on the subject of soil bacteriology, which were attended by the students of the department of agronomy. These scholarly lectures presented the field of soil bacteriology as fully as the limits of time permitted, and were a distinct addition to the work of this department.

II. FEDERAL EXPERIMENT STATION WORK.

As heretofore stated, the policy of the Department of Agronomy, during the past four years, has been to direct its investigations towards (1) the improvement of grasses and forage crops and the determination of the best methods of culture and fertilizer, and (2) the investigation of the best and most economical forms of concentrates with which to supplement the grasses and other forage crops which this State raises in relative abundance. Certain investigations have also been in progress which have sought to determine what are the differences in the essential factors of plant growth under normal field conditions. The following is a list of the experiments under way, completed, or projected during the present fiscal year:

I. Experiments begun prior to 1906 and to continue.

(1) Timothy, individual plants for variation and life history studies.
(2) Clover, individual plants of varieties for variation and life history studies.
(3) Soil fertility, an investigation into the causes of poor spots in fields.
(4) Plant ecology, an investigation into the causes of weeds affecting the productivity of corn.
(5) Corn types for student study and instruction.
(6) Potato rotation on Dunkirk clay.
(7) Grasses, growing of some sixty varieties for study and instruction.
(8) Timothy, rate of seeding and yield of hay.
(9) Timothy, selection for vigor of growth and yield.
(10) Timothy, effect of fertilizers on yield of hay.
(11) Timothy, selection of strains.

(12) Alfalfa, effect of lime, fertilizers and inoculation on yield of hay.
(13) Alfalfa, inoculation by different methods.
(14) Root crops, selection of mothers for seed production.

II. Experiments completed this year.

(1) Alfalfa and timothy, soil solution studies.
(2) Root crops, field trials.
(3) Root crops, variety trials.

III. Experiments begun or projected this year.

(1) Brome grass, individual plants for variation and life history studies.
(2) Kentucky blue-grass, individual plants for variation and life history studies.
(3) Alfalfa, study of geographic types and variations.
(4) Root crops, production trials of home-grown and purchased seed.
(5) Root crops, lime and fertilizer trials.
(6) Wheat, studies of performance and progeny records.
(7) Vetch, investigation of methods of cultures and seed production.
(8) Methods of determining the fertilizer requirements of soils.
(9) A study of soil solutions under different methods of soil treatment.

The following bulletins have been prepared by the Department of Agronomy during the year:

Bulletin 241. Second report on the Influence of Fertilizers on the Yield of Timothy Hay, by John W. Gilmore and Charles F. Clark. September, 1906.

Bulletin 242. Cabbages for Stock Feeding, by Samuel Fraser. December, 1906.

Bulletin 243. Root-Crops for Stock-Feeding, by Samuel Fraser, John W. Gilmore and Charles F. Clark. December, 1906.

Bulletin 244. Culture and Varieties of Roots for Stock-Feeding, by Samuel Fraser, John W. Gilmore and Charles F. Clark. January, 1907.

Bulletin 247. The Importance of Nitrogen in the Growth of Plants, by Thomas F. Hunt. June, 1907.

III. THE EXTENSION WORK.

The co-operative experiments in agronomy were announced in Bulletin No. 242, together with those of other departments of the college. Because of lack of funds, the variety tests mentioned in the annual report of this department have been omitted. Professor Warren is confining his attention largely to three crops: (1) clover, especially with regard to its failure to grow on certain types of soil; (2) alfalfa, especially to its soil adaptation; (3) timothy, especially to its fertilizer requirements. A number of definite and carefully planned experiments are under way in different parts of the State. Rather extensive spraying tests for the killing of wild mustard are being conducted.

A syllabus on "Agronomy for Secondary Schools," consisting of a daily set of exercises, has been prepared under the direction of Dr. A. C. True and the writer by Professor Warren. This syllabus has, with slight modifications, received the approval of the committee on Methods of Teaching of the American Association of Agricultural Colleges and Experiment Stations. Professor Warren has also prepared a syllabus on agriculture for the State Education Department which has not been accepted by them, but which is being used in such modified form that Professor Warren does not feel that he can allow his name to appear in connection with it.

The department, through Professor Fippin, has worked in cooperation with the United States Bureau of Soils in surveying and investigating the soils of Niagara county. The investigations have developed a number of important points in soil and farm management. The field work occupied four months, beginning June 25, 1906, and the results will be embodied in a report and map of the soils to be published by the Bureau of Soils of the United States Department of Agriculture.

During the closing weeks of the fiscal year, Professor Fippin will begin a reconnoissance survey of the soil conditions of the State for the purpose of correlating the soil conditions in the various physiographic regions.

In June, 1906, an agricultural survey of Tompkins county was organized and placed in charge of Paul J. White, with John B. Shepard, assistant. The survey occupied three months, June 25th to September 25th, 1906, during which time 487 farms were surveyed, including those of Ulysses, Enfield and part of Newfield townships. One of the results of this survey was to call attention to certain characteristic defects in Volusia silt loam, a soil type covering considerable area in southern New York and northern Pennsyl-

vania. Experiments have been begun by Professor Warren to determine, if possible, the cause and remedy of these defects. According to arrangements which have received your approval, this survey is to be continued under the immediate direction of Paul J. White.

IV. NEW QUARTERS AND EQUIPMENT.

On December 6, 1906, the Department of Agronomy began moving into the new agronomy building, the westernmost of the group of buildings constructed for the New York State College of Agriculture. The first lecture was delivered in the building by Professor Stone to a class of winter-course students on December 10, 1906.

This building is approximately 52 x 110 feet, and is four stories high, contains 23 rooms and has, including hallways, about 15,000 square feet of floor space.

The first or basement floor is used for instruction in agricultural machinery and will accommodate about 30 students in a section.

The second or office floor contains 6 offices, 2 class rooms, each with a seating capacity of about 60 persons, and a small laboratory with two small connecting rooms for supplies. This laboratory has 24 desks and is so arranged that by dividing the classes into four sections 96 students may be given instruction in either term.

The third or laboratory floor contains a farm crops laboratory 48 x 60 feet, fitted with 48 desks, so arranged that by dividing a class into two sections 96 students may receive instruction during either term. The room is also fitted with additional drawer space so that an additional drawer may be assigned to each student. It is the plan of the department to be able to supply each student with a desk and a locker, and thus give him a department home in which he may do his work.

The fourth or attic floor contains an office and working museum or room for the storage of materials, and a laboratory for advanced students. The office and the room for advanced students has been temporarily assigned to Dr. H. J. Webber, Professor of Experimental Plant Biology.

The equipment for this building is going into place and when completed will offer opportunity to give instruction not only for agriculture and in agriculture but also by agriculture, which, I take it, is the next step in the evolution of agricultural instruction.

During the year, Sibley College, through the courtesy of Director Smith, presented to this college a collection of fibres and other tropical products along with a substantial case in which to keep them. This collection consists of good specimens of the principal

fibres as well as fabrics, nuts, spices and dyes. This collection offers useful laboratory material for the course in tropical agriculture.

The department collection of soil-type samples has been enlarged by a number of accessions from different parts of the State and by twenty-five samples representing important soil formations through the United States, presented by the Bureau of Soils.

Of the 93 areas of arable land under the supervision of the Department of Agronomy, 36 are devoted to experiments, leaving 57 for growing general farm crops, nearly one-half of which is planted to corn the present season for the production of silage. Great difficulty has been experienced in providing land for the various important enterprises connected with the work of the college. Aside from its own lands used by the Department of Agronomy, 41 acres are leased from neighboring farms which are worked on shares. It seemed to be impossible to provide on the University farm lands to meet the requirements of Professor Webber except so far as the breeding plats for oats and for forage plants are concerned. It therefore became necessary to look for lands elsewhere and the following areas were secured from Professor Warren:

4½ acres devoted to a test of foundation stocks in corn-breeding.

2 acres to an isolated breeding patch of Reid's Yellow Dent corn.

1 acre of an isolated breeding patch of Clarage corn.

1 acre of an isolated breeding patch of Pride of the North corn.

1 acre was also secured of Mr. Tailby for an isolated breeding plat of Sturgis hybrid corn.

An earnest effort was made to find eight or ten acres of land that might be available, which Dr. Lyon could start the preliminary investigations necessary to establishing his work in the soil investigation. No suitable area seemed to be available and the effort finally was abandoned.

V. PERSONNEL.

The work of the department has been carried forward by the following persons:

T. L. Lyon, Professor of Experimental Agronomy.

John L. Stone, Assistant Professor of Agronomy.

E. O. Fippin, Assistant Professor of Agronomy with reference to Soils.

John W. Gilmore, Assistant Professor of Agronomy.

George F. Warren, Assistant Professor of Agronomy.

Charles F. Clark, Assistant Agronomist.
George W. Tailby, Farm Foreman.
Miss Grace Stanyon, Stenographer.
Paul J. White, Assistant in Farm Crops.
John B. Shepard, Assistant in Soils.
Morgan W. Evans, Assistant in Soils.

During the absence of the writer, Professor Lyon acted as head of the Department of Agronomy and during the illness of Professor Fippin gave the instruction to undergraduate students in soils. He has been occupied during the year in organizing investigations in certain soil problems and has taken charge of certain experiments already under way.

Professor Gilmore has given instruction in agronomy 11, 111, 16 and farm machinery 52. With Mr. Clark, he has conducted the experimental work along plant improvement and production lines.

Professor Stone has given the instruction in agronomy to winter-course students, conducted courses in farm practice throughout the year, and has had the business management of the University farm.

Professor Fippin has given the instruction in agronomy 1, 3, 4 and 5.

Professor Warren has had much of the extension work along lines indicated above.

The head of the department has had personal charge of agronomy 12, 13, 14 and 15.

Whatever the Department of Agronomy may have been able to accomplish, either as an agency of instruction or research, is due to the ability, earnestness and singleness of purpose of the members of the staff. It is a pleasure to be able to testify to their personal co-operation and to the fidelity with which they have carried forward the work of the department.

THOMAS F. HUNT,
Professor of Agronomy.

ANIMAL HUSBANDRY.

I. Teaching Work.

The instruction in this department is comprised in the list of courses appended herewith: 31. Animal Husbandry; 32. Advanced and Seminary Work in Animal Technology; 33. Practice in Feeding and Stable Management; 34. The Horse; 35. Animal Mechanics and Exterior; 36. Animal Husbandry.

During the year 1906-7 instruction was given in

Course 31 to 87 students,
Course 32 to 9 students,
Course 33 to 3 students,
Course 34 to 22 students,
Course 35 to 12 students,
Course 36 to 31 students.

In addition to these, there were 155 winter-course students in a three-hour course in "Feeds and Feeding," and 52 winter-course students in a three-hour course in "Breeds and Breeding."

Notwithstanding the work in all these courses was seriously handicapped by the necessity of occupying temporary quarters, and the impossibility of using part of the equipment, the general standing maintained by the students in this department was above the average, and the work may be said to have progressed satisfactorily so far as the progress of the students is concerned.

II. Experimental Work.

The experimental work in the Department of Animal Husbandry has been conducted in the usual way for the past year. Several investigations are in progress, the most notable of which are

(a) Experiments as to the profitable production of beef in New York State.

(b) The development of winter lamb raising.

(c) The utilization of skimmed milk in the production of pork.

(d) Experiments in the breeding and development of dairy cows.

This work is all continuous, and has now been in progress for several years, but it seems desirable that it should be continued for some time longer before publishing results. Additions to the force

of the department have made it possible to prosecute this work with greater vigor during the coming year, and also to add some new lines of investigation, notably:

(a) Experiments on substitutes for milk in raising calves.

(b) The utilization of cheap molasses as a food for animals.

No bulletins have been published during the year.

H. H. WING,
Professor of Animal Husbandry.

SUB-DEPARTMENT OF POULTRY HUSBANDRY.

The work of the Sub-Department of Poultry Husbandry has been conducted along four principal lines: Instruction, Experimentation, Correspondence, Administration.

In all four lines a substantial advance has been made over previous years, due to increased facilities and the knowledge gained by experiencce in developing the work.

The total number of students taking some form of poultry instruction during the year was 173. The increase in the winter poultry-course over the previous year was 30 per cent. Forty-six students began the course.

It has been thought wise to increase course 37, the lecture course, from two to three hours per week. In view of the great importance of the practice work which is given in course 38 (afternoon laboratory and plant practice), it should be combined with course 37, the lecture course, making a four-hour course, three hours lecture and recitation and one hour practice, as soon as the laboratory facilities and teaching staff can be provided. The practice course should continue during the entire college year and not cease during the winter poultry-course as is now done, owing to the lack of facilities to teach both classes at the same time.

The investigational work has been placed on a better working basis than heretofore by practically divorcing it from the instructional work. It is hoped to make the separation complete. The ideal arrangement would be to have the investigational work on a separate plant. This would make a complete division of work and would avoid disturbance and error which is likely to occur when many students are constantly among the pens.

The experiments which have been conducted during the past year are as follows:

(1) Three experiments on the philosophy of the molt.

(2) Three experiments to determine the function of grit.

(3) One experiment on poultry house construction (Glass vs. Cloth windows).

(4) Four experiments on feeding for egg production.

(5) Three experiments with methods of incubation.

(6) Two experiments of methods of brooding.

(7) Two experiments on methods of feeding chickens.

(8) One experiment in conditions governing the vitality of fowls and fertility and hatchability of eggs.

(9) One investigation on the cause and cure of so-called white diarrhea in chickens. In addition to several experiments which we have conducted with incubators, brooders, methods of feeding, etc., 143 persons have co-operated with us in furnishing data giving the results of their experience with mortality in chickens.

Data has been accumulated for subject matter for eight bulletins.

During the year, two bulletins have been published: No. 246, on the "Gasoline Heated Colony House for Brooding Chickens," and No. 248, "Handy Poultry Appliances," the editions of which, 25,000 of the former and 20,000 of the latter, is practically exhausted.

The correspondence has steadily increased during the year and now averages fifteen letters daily. There were 3,596 letters written during the year. Correspondence will undoubtedly increase with the publication of each new bulletin and the sending out each year of new classes of students.

The income from sales and laboratory fees has steadily increased each year as the plant has increased in size and efficiency. We now have on hand 728 mature stock, including fowls and ducks (and 1,227 young stock), making a total of 1,955 head of poultry, valued at $2,200. This is a marked increase over previous years, both in quantity and quality.

RECOMMENDATIONS.

The demand for instruction in Poultry Husbandry and the call for information on important problems yet unsolved, warrants a large increase in facilities for instruction and for investigation.

At the earliest possible date a farm of not less than forty to fifty acres should be purchased.

This should be devoted to two specific purposes: first, a plant where all of the investigational work is performed; second, a demonstration poultry farm to be conducted on a substantial commercial basis, where students and visitors can see a poultry farm in actual operation as it should be conducted; a poultry farm which can be taken as a pattern by our students and others. Such a farm is necessary in connection with an educational institution as an object lesson to carry conviction.

The commercial plant could be made to pay a good profit on the investment. On this farm would be reared and kept the stock which would supply the instructional plant, which should always

remain in close proximity to the main college group in order to be easily accessible to students. The present location appears to be the most desirable, in fact the only site available. With all the north slope available for the instructional plant, it would furnish sufficient land for instructional purposes for many years to come, provided the stock could be moved to less congested quarters when not desired for use for instructional purposes.

There are few, if any, agricultural subjects in which practice courses can be taught to better advantage than in Poultry Husbandry. It is absolutely essential to the successful teaching of Poultry Husbandry that at least half of the students' time be occupied in actually doing the work in the laboratories and on the plant.

This will be utterly impossible of accomplishment if the plant is not easily accessible, owing to the fact that the practice work requires the student to be at the plant a large part of the time during the day, especially early in the morning and late in the afternoon.

There is immediate and urgent need for a large building for offices, laboratories, incubator cellars, killing room, general work room and a judging pavilion. It will be necessary to have these before it will be possible to require practice courses of all of the students who elect Poultry Husbandry and before it will be possible for us to accommodate all of the students who desire to take the winter poultry-course. At the present time we are occupying continuously an office and reading room at certain dates and hours, a lecture room and recitation room in the Dairy building at no little inconvenience to the Department of Dairy Industry.

Because of the lack of facilities, due principally to insufficient number of pens, the small incubator cellar, killing room, carpenter shop and laboratories, we will be unable to accommodate more than two-thirds of the students who will seek admission to the winter poultry-course this year. We have increased our capacity over previous years until we now, September 30th, can accommodate fifty students and have accepted forty-seven signed applications for the winter poultry-course. Notwithstanding the fact that we undoubtedly have a larger teaching staff, better equipments and general facilities for teaching Poultry Husbandry than any other agricultural college, it is apparent that if we are to meet our obligation to the State and to the Nation, we should have more land, buildings, equipments and men.

JAMES E. RICE,
Assistant Professor of Poultry Husbandry.

HORTICULTURE.

The various activities of the department divide naturally into two parts—those concerned with instruction, and those concerned with investigation. Again each of these branches divided into that part conducted at the College of Agriculture in Ithaca, and that conducted outside in the State.

I. Teaching Work.

(a) *In the College.*—The instruction given at the college falls directly or indirectly under one or other of the following heads: pomology, the study of fruits and fruit grouping; cleri-culture, the study of vegetables and vegetable culture; flori-culture, the study of flowers and their culture. Manufactures, or horticultural technology, is another and important branch which we have not yet developed, owing to lack of facilities and equipment. Instruction in these branches has been given as efficiently as possible. The new equipment will add greatly to the ease of giving the courses, and the completeness of the laboratory courses.

(b) *In the State.*—The various members of the department have served on the regular staff of the Farmers' Institute workers in the State in addition to responding to frequent calls for special lectures from granges, farmers' clubs, fruit-growers' organizations, and the like.

The winter course work now being a recognized part of extension teaching, it is proper to consider it here. A special winter-course in horticulture, for students desiring specific training in the fundamentals of fruit growing and vegetable gardening, was organized two years ago. The attendance was light at first, but has increased gradually each year until at the present date of writing (November 12) the department has ninety-five per cent. more applications than were received at this time last year. The course appears to meet a well-defined need.

II. Investigation Work.

All work done by the Department of Horticulture has been supported by State appropriation. As teaching is our main effort, and as the funds for investigation have been very limited, the work conducted was mainly of such a type as involved little expense.

It is very difficult to estimate with accuracy the probable expense of giving a course in which most of the illustration material must be purchased; consequently the departmental appropriation was used largely for teaching essentials, and such as remained over for experimental work. In future, our position will be much more satisfactory. So much for a general statement.

(a) *Studies and investigations on the home grounds.*

(1) *Forcing-house investigations. Influence of acetylene light on plant growth.*—This study covered three years, being concluded in April, 1907. In this work the department received hearty coöperation from the Union Carbide Company, of Chicago, who furnished several tons of carbide of calcium for the work. The results are now practically ready for the printer.

The use of ether in the forcing of plants.—These studies covered two years by graduate students, working under my immediate supervision. Interesting results are now being compiled for publication.

(2) *Monographic studies of the peony.*—This comprises a coöperative study of the cultivated peony conducted between the Department of Horticulture and the American Peony Society. It includes a careful study of the culture, character and nomenclature of the vast list of cultivated peonies. A first report has been issued in the form of a check-list of all peonies named in leading horticultural publications. A bulletin containing cultural directions and careful descriptions of select list of varieties is now ready for the press. This work is to be credited to Professor J. Eliot Coit, now of the Arizona Experiment Station.

(3) *Garden Beans: A Monograph.*—This is the title of a manuscript by C. D. Jarvis, and is a painstaking effort to classify the cultivated varieties of garden beans. It is ready for the press.

(b) *In the State.*

(1) *Orchard surveys.* (a) Niagara county.—The orchard survey of Niagara county commenced three years ago, has been continued each season since and was finally concluded in September, 1907. This includes an examination of the principal apple and peach orchards of the county. The data are being compiled for publication in the near future.

(b) Orange county.—A beginning on a survey of the fruit counties of eastern New York was made by a study of the apple, peach and grape of Orange county. A searching examination of the orchards of one township was made, and this was supplemented by a more rapid survey of prominent orchards in the northern central part of the county. In both Niagara and Orange counties, the

Bureau of Soils of the United States Department of Agriculture kindly co-operated to the extent of making the soil observations.

(2) *Experiment with little peach and peach yellows.*—The mysterious little peach disease has become a serious menace to the peach industry about Youngstown, where peaches form one of the most important and profitable crops among the numerous fruit growers, and a three-year experiment in the Youngstown orchards has been undertaken by this department in co-operation with the Bureau of Plant Industry at Washington, D. C., looking to the control of its ravages. Experiments in other places have shown eradication to be the only promising line of treatment, and that is accordingly the one pursued in this experiment. The method, in brief, is to inspect each orchard twice each year, late in August and about the middle of September, blazing with an ax each diseased tree and requiring the grower to remove it immediately. The second inspection serves to catch any new cases, or any that were overlooked the first time, as well as to enable a final decision on doubtful cases which were allowed to pass the first time, since the approaching maturity of the fruit makes diagnosis easier. A careful count is made of both diseased and healthy trees, and the ratio between the two as the experiment advances shows at once the efficacy of the treatment. Peach yellows is more or less prevalent at Youngstown, and has destroyed many trees, though it is not at present as abundant and menacing as the little peach. The same inspections served for both diseases, and the treatment was identical. It is too soon yet to report on the results of the experiment. The figures show a considerable reduction in the percentage of diseased trees, but this is, of course, in some measure accounted for by the destruction of large numbers of marked trees. On the other hand, the removal of infection centers last year seems, in many cases, effectually to have checked the spread of the disease. Another year should show decisive results.

(3) *Vegetable garden survey.*—The unquestioned value of the orchard survey at present being conducted by this department has suggested the organization of a similar survey of vegetable gardens. Preliminary steps were accordingly taken this summer to begin such a survey on Long Island, one of the important trucking regions in the State, and undoubtedly destined from its favorable location, sandy soil, and long season to assume a leading position in this industry. Special blanks have been devised for gathering the data. A reconnaissance of the island was made to gain a general idea of crop conditions and the location of the trucking areas,

and data was secured from some of the largest truckers. It is planned to complete the survey next summer. Investigation in charge of Assistant Professor Judson.

(4) *Experiments for the control of grape-rot.*—Extensive experiments have been conducted in a vineyard in the Seneca Lake region, having for their purpose the control of the black-rot of grape. Supplementary experiments have been conducted in Yates county for the suppression of the same disease. These experiments have been carefully planned by the writer in conjunction with Assistant Professor Wilson, under whose direction the work has been prosecuted. Grape-growers have suffered heavily in recent years from the ravages of this parasite, and it is gratifying to be able to state that these experiments indicate that the loss may be obviated in large measure by vineyard sanitation and the application of the copper salt sprays.

(5) *Bordeaux injury.*—An investigation of the injury of apple foliage and fruit resulting from spraying with Bordeaux mixture was made during the year, but without definite results.

JOHN CRAIG,
Professor of Horticulture.

DAIRY INDUSTRY.

The department moved into the new dairy building soon after the opening of the fiscal year. The building is not yet finished. During the entire year our work has been considerably handicapped by the presence of the builders.

The different lines of work may be discussed under six separate headings, as follows:

I. Teaching Work.

There were the same number of classes as in the previous year. Although classes were larger than in the previous year, they were not as large as they should have been because some students who had intended to take the work decided not to do so when they found the working rooms were incomplete and practice work would be badly interrupted.

II. The Winter Dairy-Course.

This class was practically the same size as in the previous year,—about 90 students. They averaged high in ability and made a good record of attendance. Only a few left before the term closed.

Thus far there has been no serious lack of positions for competent winter-course students. Yet I think I see a difference in the demand for these young men. Certain large dairy concerns are extending their operations throughout the State, buying plants which have been owned by individuals or farmers' companies and changing these from factories which make butter and cheese into stations where milk is prepared for shipment to New York City. Frequently such a change in the use of the milk means also the dismissal of a man who has been well trained and who commands a salary of $60 to $100 per month, and the employment of one who has had little experience and is willing to work for about $50 per month. A few such changes do much to decrease the pressure for competent operators of butter and cheese factories, and this in turn has its influence in holding down the attendance of the winter dairy-course and in checking the demand for those who take this work. It will be many years before there is any great difference in the number of men employed in making butter and cheese in New York State factories, and there are excellent opportunities

along this line. Yet the point mentioned seems to be responsible for some diminution of interest.

Last winter we tried the experiment of opening the winter dairy-course, as the other winter-courses, early in December, instead of early in January. There are many advantages in this new arrangement, as far as a dairy-course is concerned. We find it easier to buy milk because we want to begin doing so at a time when milk is far less scarce than it is early in January. The early opening means also early closing, and this is an advantage to those who secure positions requiring their presence in the month of March. Furthermore, the early opening gives opportunity to conduct instruction work during the Christmas holidays, which is a distinct advantage to the winter-course students as they then receive the full time of the instructors.

III. CORRESPONDENCE.

The department received and answered about six thousand letters during the year. Many of these referred to difficulties in connection with dairy work and the replies included a large number of carefully prepared and lengthy letters of advice.

IV. FIELD WORK.

Former winter-course students were visited during the summer for the purpose of determining their fitness to receive certificates of proficiency. Whenever possible visits were extended to students who were not candidates for certificates, and often also persons who have not been connected with the University. Most of these visits were made by Mr. Hall and Mr. Ayres, and a few by Mr. Griffith and the writer. This is a highly important part of the work of our college. It needs to be considerably extended. We find that by means of an occasional visit the quality of the products of some establishments can be maintained at a higher point than would be obtained otherwise.

The writer has attended numerous meetings in different parts of the State and usually spoken on some subject connected with the production of milk or its profitable handling.

V. INVESTIGATION WORK.

An interesting study of the milk supply of Ithaca was begun and well advanced during the year. In this work we are in cooperation with Dr. H. H. Crum, health officer of Ithaca. We

find conditions about the same as in other small cities, and we believe that methods for milk inspection, suitable for small cities and towns, will be worked out as a result of our study in this district.

Other investigations have been started but not yet carried to completion because of lack of sufficient time. One which promises to be of special value is an investigation of methods for determining the amount of moisture in butter. Since the enactment of special laws and the promulgation of special regulations of the Bureau of Internal Revenue, in reference to the water content of butter, it has become necessary for butter-makers to watch this feature of their work with care. We are working on a test for determining the amount of water, which we think superior to those in common use and hope soon to be able to publish.

VI. COMMERCIAL WORK.

Since moving into our new building we have further developed the plan of purchasing milk throughout the year in order that we may have a supply in the college year sufficient for our needs, from our own patrons. The plan is working well. During the height of the season last summer, we received at our three skimming stations and at the main dairy building a total of about 25,000 pounds of milk daily. This milk was received and handled the same as would be done at a well-conducted creamery or cheese factory. We have not succeeded in getting sufficient milk from our own patrons for all requirements, except in four or five winter months. It will probably not be more than two or three years before our own patrons will furnish sufficient milk for the entire year. We have been obliged to buy milk through jobbers and ship it a long distance, thus paying profits to the jobbers, transportation to the railroad, and suffering more or less loss from waste and bad quality incident to shipment.

R. A. PEARSON,
Professor of Dairy Industry.

ENTOMOLOGY.

I. Federal Experiment Station Work.

The study of insect enemies of timothy, which we begun last year, has been actively prosecuted this year. Most of the time has been spent in studying the joint-worms which infest wheat, timothy and other grasses. The life-history of the joint-worm of timothy has been well worked out. Much has been done on the parasites which infest these joint-worms, and some very interesting facts have been ascertained regarding the inter-relation of these parasites and their hosts. Excursions have been made into different parts of the State to collect the host plants of these insects, and extensive breeding experiments have been performed, which have resulted in much valuable information.

Some observations have been made on other insect enemies of timothy, and considerable progress has been made towards a monographic study of the literature of timothy insects.

Another interesting piece of work, which is being done under the auspices of the Federal Fund of this station, is a study of a new insect which we have found to be very common in the seeds of many kinds of apples. No apple-seed-infesting insect seems to have been heretofore observed in this country. The adult insect has been reared and found to belong to a group, the members of which have been supposed to be parasitic on other insects. Another season's observations and breeding experiments are necessary to complete our knowledge of this interesting new apple pest.

II. Extension Experiment Work.

Under the auspices of the State funds, considerable work has been done by this division of the station along the line of co-operative experiments with farmers, and also the study of some minor insect pests.

We are studying an interesting insect, which mines the leaves of the Sour Gum or Pepperidge tree. Good pictures of the work and early stages have been secured, but we have thus far failed to breed the adult insect. The life-history of the Tingid bug, which is often injurious to rhododendrons, has been worked out and a practicable remedy found. Two other insects, whose caterpillars mine the leaves of arbor vitae and hemlock, have also been under supervision, but another season's work is required to clear up some points in their life-histories.

What appears to be a new plum pest has just been brought to our attention. It mines the leaves of plums and prunes and has done considerable damage in one large New York orchard. It was too late when our attention was called to the insect to find it at work, but it was soon located in its hibernating quarters, and we hope to secure the adult insect and study its habits further next season. We hope to be able to complete our study of the above minor insect pests of fruit trees, forest trees and shrubs during the coming season, and thus secure material for at least two bulletins.

In the list of co-operative experiments offered to New York farmers during the past season, six different experiments were suggested by this division of the station. They were as follows: poison sprays for plum and quince curculios; spraying for grape root-worm; spraying and timely cultivation for the rose-chafer; spraying for oyster-shell and scurfy black-scale in June; all sprays for the San José scale; and fumigation of mills for grain pests. No one offered to make the co-operative experiments under the first three headings. A few fruit-growers, however, sprayed the oyster-shell bark-scale under our direction in June with very satisfactory results, and several aided us by sending in infested branches from time to time, so that we might determine approximately the date of hatching of the eggs. We co-operated with a few fruit-growers and supplied part of the material for spraying the San José scale with a miscible oil. In general, the results were very satisfactory. One fruit-grower practically annihilated the scale on the sprayed trees. We assisted in the fumigation of one flouring mill for grain pests, but as the owner failed to carry out some of our recommendations in the preparation of the mill for fumigation, the results were not very satisfactory. In this connection it might be of interest to report that we have successfully fumigated single rooms, suites of rooms, and in one case a whole house from cellar to garret with hydrocyanic-acid-gas for household pests.

Teaching, correspondence work and preparation of papers and material for institutes, fruit-growers' meetings and fairs has occupied a large share of our time. While all this kind of work is valuable and helpful, it is taking more and more time each year and leaving less time to be devoted to investigational or experimental work.

J. H. COMSTOCK,
Professor of Entomology and General Invertebrate Zoology.

M. V. SLINGERLAND,
Assistant Professor of Economic Entomology.

AGRICULTURAL CHEMISTRY.

During the year 1906-7 the work of the chemical department of the College of Agriculture was done almost entirely by Dr. Jas. A. Bizzell. In July of the present year he was transferred to the work in the experiment station and from that date the writer did the work till October 1st, when more assistance was available.

The work may be summarized as follows:

	Samples
Insecticides	15
Eggs and poultry products	20
Fertilizing materials	10
Feeds	24
Soils	13
Magnesia pipe coverings	12
Root crops for agronomy department	118
Total	212

The work on root crops for the Department of Agronomy is to be continued and arrangements have been made for the examination of about 1,000 samples during the present autumn.

G. W. CAVANAUGH,
Assistant Professor of Chemistry in Its Relations with Agriculture.

PLANT PATHOLOGY.

The work of the Department of Plant Pathology during the past year has been conducted along two general lines: teaching and investigation.

I. Teaching Work.

The teaching has been of two general types: student instruction in the College of Agriculture, and extension teaching among the people of the State.

Student Instruction.—The course in plant pathology was offered for the first time this year in the College of Agriculture. Thirty-one students took this course. Although the accommodations in the lowest basement of the dairy building, where the work was given, were not of the best, the students nevertheless manifested an excellent interest and the work was satisfactory. A course in farm botany and one in plant diseases was given to the winter-course students. Thirty-four students took work in these two courses. There were, besides these, several graduate and special students doing work in the department. Considering the facts that the department had no permanent laboratories or accommodations of its own, and that the equipment for the work was entirely inadequate, the teaching work accomplished during the first year was quite encouraging.

The extension teaching has been mainly of three sorts: first, correspondence with farmers of the State, chiefly in regard to plant diseases and their control. This has been greatly stimulated and extended by means of the disease survey work conducted in co-operation with the Bureau of Plant Industry of the United States Department of Agriculture. A number of growers about the State have consented to act regularly as plant-disease reporters from their section, and contributed reports and specimens from time to time during the past season. This promises to be one of the most effective means of extension teaching in plant pathology. Second, a number of talks, lectures and field demonstrations before farmers' meetings of various kinds about the State have been given. Third, the practice established last year of making plant-disease exhibits at fairs about the State has been continued and extended. Exhibits were made at five fairs, including the State fair. There were several requests from other fair associations for an exhibit. These

could not be met because of lack of equipment and men to duplicate exhibits at fairs held during the same week. Some member of the department was constantly with the exhibit to show and explain the diseased plants, photographs and charts. Over fifteen hundred cards giving the name and address of the plant pathologist were handed out to persons making especial request for them. The large crowds which constantly gathered at this exhibit spoke most encouragingly for this form of extension teaching.

II. INVESTIGATION WORK.

The work of investigation during the past year has been devoted to a continuation of a number of problems taken up in 1906 or earlier. A few new problems have been undertaken. Owing to the interruptions and delays incident to the building and equipping of new quarters for this department, the investigation work has not been very satisfactory. With practically no cultural or microscopic facilities for doing work, some of the problems have had to go over to another season. Much time has been consumed in the planning of furniture and equipment for the new quarters in the top of the agronomy wing of the College of Agriculture. I am, however, able to report some progress on the following problems:

(1) *Bean Anthracnose.*—Work on the control of the bean anthracnose has been continued. Although this disease did relatively little damage in the State this year, owing to the dry weather, it was nevertheless generally present. Careful germination tests of a considerable number of samples of bean seed from all over the State and from other states showed the disease constantly present to the extent of four to fifty per cent. Exception must be made in the case of one lot of seed sent in from the irrigated lands of Colorado. These were entirely free from the disease as shown by test. A small plot planted to these beans on the University farm gave a clean crop. A similar plot grown from seed known to be diseased gave a large percentage of spotted pods. We feel certain that the practical control of the disease must be by the use of clean seed rather than by spraying. A preliminary report on this problem is now in preparation.

(2) *Alternaria Blight of Ginseng.*—The work on the alternaria blight of ginseng, which was largely completed last year except for some culture work, has had to go over until another year because of lack of facilities for doing this work. The bulletin on this subject has therefore not appeared.

(3) *Fire Blight.*—The work on fire blight has been prosecuted to a limited extent. Some interesting facts and observations in regard to the manner in which this disease is carried over winter have been collected, together with a number of excellent photographs.

(4) *Septoria Leaf Spot and others.*—The work on the septoria leaf spot of tomatoes has received but little attention this season. The problem, however, has not been dropped and it is planned to continue the work next season. The work on hollyhock rust and the root-rot of peas have likewise had to go over until another season.

Of the new problems taken up during the past year, the following are of most importance:

(1) *The Black-rot of Grapes.*—The heavy losses from this disease during 1906, especially in the Niagara grape growing sections of the State, created a demand among the growers for a more thorough investigation into the nature and control of this disease. Work on this problem was begun about the middle of June. Mr. Donald Reddick, assistant in plant pathology, was put in direct charge of the work. A temporary field laboratory, well equipped for microscopic and cultural work, was established in a large Niagara vineyard near Romulus, N. Y. Mr. Reddick was at this laboratory constantly from the middle of June until the end of August. The work so far has been confined entirely to a study of the life history of the black-rot fungus (*Guignardia bidwellii*). The first season's work has been very satisfactory in giving us a preliminary survey necessary to the intelligent prosecution of the work on this disease. It is planned to spend at least three years on the problem before making a final report.

The establishment of a field laboratory for the study of the disease has been a most satisfactory experiment. There is no place so admirably adapted to the study of any disease as in the field where it is actually developing under normal conditions. It is planned to continue this policy of field laboratories not only for the study of the black-rot but for the investigation of other important diseases that we may have in hand from time to time.

(2) *Loose Smut of Wheat.*—The loss from the loose smut of wheat has been gradually increasing during the past three years. This year it undoubtedly destroyed at least 10 per cent. of the wheat crop of the State. A careful study of the nature and control of this disease has been undertaken. It is expected that a bulletin on this subject will be issued within a year or so.

(3) *Diseases of Peonies.*—A study of the diseases of peonies has been begun. The fact that a large collection of peonies is being grown by the horticultural department has suggested this line of research. As chairman of the committee on peony diseases of the American Peony Growers' Association, the writer has excellent opportunities to get diseased material for study and experiment. The work for the coming season is to be chiefly the getting together of the literature on peony diseases and the publication of a digest of the same.

The Plant Disease Survey, already referred to, is to be, to a certain extent, of an investigational nature. It has for one of its objects the collection and classification of data in regard to the occurrence and distribution of plant diseases in the State. It is planned to push this vigorously next year.

The prospects for the coming year are most encouraging. With new quarters, thoroughly equipped in nearly every way for the proper prosecution of the teaching and investigational work, with an increase of five hundred dollars for maintenance, and with many interesting and important problems awaiting solution, the staff of the Department of Plant Pathology looks forward to the coming year's work with pleasant anticipation and enthusiasm.

H. H. WHETZEL,
Assistant Professor of Botany.

NATURE-STUDY EXTENSION WORK.

The pedagogical extension teaching of the college consists of the Junior Naturalist and other work with children, and the Home Nature-Study Course and correspondence for teachers. The former is in charge of John W. Spencer and Miss Alice McCloskey, and the latter of Mrs. Comstock.

At the close of the second year, 1906-7, the organization known as the Junior Naturalist Club consisted of 18,966 children and 808 clubs. Hundreds of applications were made for admission to the club after the fund which provided for it was exhausted. During the year, 20,115 letters or compositions were received from Junior Naturalists. These compositions covered a wide range of country life subjects. It was very evident that in New York State an interest in the usefulness of this educational work had been awakened.

On investigation it was found that 80 per cent of the children in correspondence with the University were in communities of less than 8,000 inhabitants, a large number being in distinctly rural districts. The fact has led us to feel that the purpose for which the Junior Naturalist Clubs were organized has been fairly well accomplished. General nature-study has prepared the way for introducing nature-study agriculture into the rural schools.

Now that general nature-study has become a part of the school curriculum there is no longer need for the New York State College of Agriculture to continue propaganda in this field. The value of educating a child in the terms of his environment has been acknowledged, and as a result, a nature-study syllabus for use in all public schools has been prepared by the State Education Department. The New York State College of Agriculture has now an opportunity to develop a direct interest in work in elementary agriculture. Teachers in rural schools throughout the State can be helped to give instruction in the principles of agriculture from the nature-study point of view, such lessons to be so prepared as to have an all-round educational value. Therefore, at the close of this year, we feel that the aim for which we made propaganda has been accomplished, and that our future work with the children of New York State will be nature-study agriculture; this outlook is fully explained in the first issue of the Cornell Rural School Leaflet, issued October, 1907.

A start has been made toward interesting members in institutions for dependent children in the soil and plant growth. This undertaking is a different problem from that of children in the public schools, and up to the present time progress has not been so rapid, yet the movement is growing and is promising.

HOME NATURE-STUDY COURSE.

Owing to the fact that the State Education Department issued a syllabus of nature-study and agriculture, which the teachers in the training classes are to follow, it seemed best to change the character of the nature-study leaflets to meet this new need. The home nature-study leaflets, therefore, were devoted to topics suggested in this syllabus, and in each case when it was possible the lessons have been made agricultural in their application. It has seemed necessary to make the leaflets a medium for information to the teachers concerning the topics treated. We have hoped by this means to give the teachers confidence in their knowledge of the subjects, and thus to make it easier for them to teach nature-study. In our four leaflets, we covered 56 subjects in 177 lessons. This change in our leaflets has eliminated the task of correcting papers. However, there has been much correspondence concerning the work. We have been in receipt of nearly a thousand letters during the year, and have had about 700 lessons also.

The following lessons have been sent out:

October-November	2,270
December-January	2,585
February-March	2,634
April-May	2,655
	10,144

Teachers in New York State	227
People outside of New York State	127
Pupils in training classes	1,907
Libraries in New York State	394
	2,655

We have received many letters during the year expressing satisfaction in the leaflets, and we have every reason to believe that the work given in the Home Nature-Study Course meets an actual need.

ANNA BOTSFORD COMSTOCK,
Lecturer in Nature-Study.

THE READING-COURSES.

The statistics of the Farmers' Reading Course for the year ended September 30, 1907, are as follows:

New readers in:

Series I. Soil	1,066
Series II. Stock-feeding	111
Series III. Orcharding	77
Series IV. Poultry	849
Series V. Dairying	76
Series VI. Farm Buildings	30
	2,209
Old readers renewed	1,057
	3,266

Discussion-papers returned:

Series I. Soil	557
Series II. Stock-feeding	369
Series III. Orcharding	306
Series IV. Poultry	725
Series V. Dairying	302
Series VI. Farm Buildings	271
Series VII. Helps for reading	810
	3,340
Total number of clubs	34
Total number of letters written	10,512

The statistics of the Farmers' Wives' Reading Course are as follows:

New readers in:

Series I.	199
Series II.	1
Series III.	0
Series IV.	0
Series V.	7
	207

Previously reported:

Series I.	1,394
Series II.	2,053
Series III.	6,863
Series IV.	4,461
Series V.	7,109
	21,880
Total	22,287
Discussed-papers returned	2,931
Total clubs	59

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Agronomy (Extension Work)

CABBAGES FOR STOCK-FEEDING

By SAMUEL FRASER

AND

LIST OF COÖPERATIVE TESTS FOR 1907

ITHACA, N. Y.

PUBLISHED BY THE UNIVERSITY

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CABBAGES FOR STOCK-FEEDING.

In the search for good succulent feed for live-stock, the cabbage should not be overlooked. For this purpose, the cabbage is to be compared with roots. A popular sketch of methods of growing cabbages for this purpose is needed.

The only form of the cabbage grown in this State for stock-feeding is the common or heading cabbage, usually spoken of as "cabbage" and the one kind which is understood when this term is used. The Savoy is used for stock-feeding in Europe, but not in America, so far as known

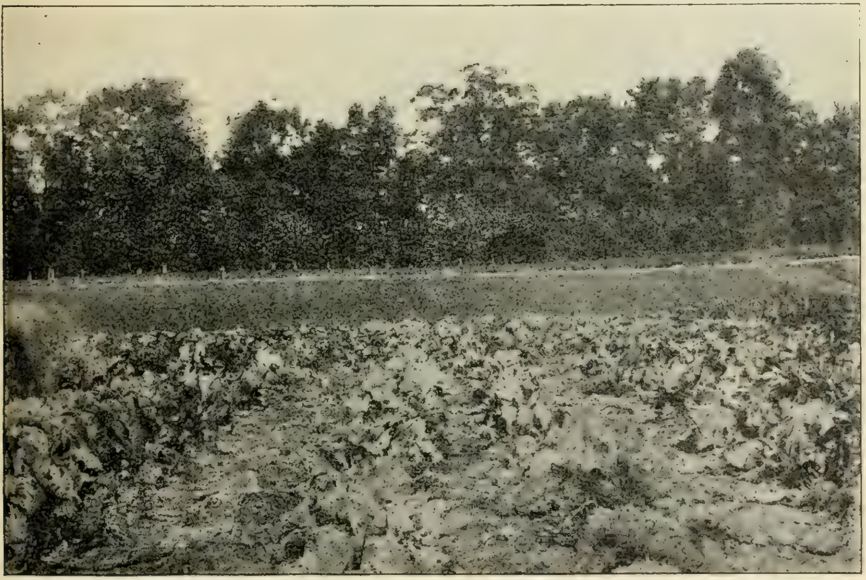

FIG. 8.—*Cabbages are a cleaning crop. Note the freedom from weeds.*

to the writer. The cabbages, kales, turnips, rape and kohl rabi are closely related. They belong to the mustard family, or Cruciferæ ("crucifer" is cross-bearing; in this connection its alludes to the fact that the four petals of the flower are arranged in two opposite pairs, like a cross). Some of the cruciferous plants are weeds, as mustard, charlock, shepherd's purse, pepper-grass.

Among the kales, practically none are grown in America, although the British farmer is extending his acreage of the thousand-headed cabbage or kale, and other forms are grown in parts of Europe. That none of these latter are of value to this country hardly seems possible, and, no doubt, in time, some will receive a fair trial. Kohl rabi will be treated in a bulletin on root-crops (No. 243).

Climate and Soil.

The climate of New York is well suited to cabbages, the crop being extensively grown in such distant parts as Long Island and western New York, and apparently with success in both places.

The soil considered best adapted is one rich in organic matter. Good crops can be raised on almost all types of soil provided they contain the above requisite, are in good physical condition and contain an adequate although no excessive supply of water. Cabbages differ from almost any other farm crop in that their successful production is little influenced by the type of soil on which they are grown, or, in other words, they show a wide range of adaptability, so far as this factor is concerned. Undoubt-

FIG. 9.—*A good Autumn King cabbage. The proportion of head to outer leaf is good.*

edly, this power of adaptability to varying soils was an important factor in leading the primitive people of northern and central Europe to cultivate the cabbage, and, having been grown by the common people of these regions, under all sorts of conditions of soil and climate, with more or less success, from prehistoric times until the present, this power of adaptability has been preserved.

The soil should be loose, friable and well prepared, deep fall-plowing being advised. An application of 10 to 20 tons of manure per acre may be made before plowing. In spring after harrowing, an application of well-slaked lime, at the rate of 1,000 pounds of quick lime per acre may be made, and harrowed in. The harrowing should be done before rain falls, otherwise the lime cannot be so readily incorporated with the soil.

The advantages of lime for cabbage are recognized by many growers, and one of its benefits is its action in destroying the fungus that causes club-root. After the lime is harrowed in or before liming, it may be advisable to apply part of the fertilizer. Amounts frequently used are 400 to 800 pounds of acid phosphate, 15 to 16 per cent available, or its equivalent, i. e., 60 to 120 pounds of phosphoric acid; 100 to 150 pounds of muriate of potash, and 50 pounds of nitrate of soda per acre. Manure, lime and fertilizers should be uniformly applied. This important matter should not be neglected. If the seed is sown where the plants are to grow, the last harrowing should be done with the Meeker harrow or some tool which will fit the surface equally well.

FIG. 10.—*Danish Ballhead. The proportion of outer leaf to head is larger than in Fig. 9, but the head is denser.*

Seed and Sowing.

The number of seeds in a pound varied in 1905 from 87,000 in the case of Danish Ball to 143,000 in the case of Surehead. The viability varied from 71 per cent. to 92 per cent. in different varieties.

Since seed is liable to convey the germs of black-rot, it may be treated by dipping it in a solution of formalin of the strength of one part of formalin to 240 parts of water, and then drying before sowing. In drying, spread the seed thinly and dry as quickly as possible and then put it in a clean bag to prevent re-infection.

FIG. 11.—*Surehead. Yields well.*

Seed may be sown in beds and then transplanted, or sown in the field where the plants are to grow. The latter is preferred by many commercial growers. For the more economical sowing of the seed, a machine is required that will drop four to six seeds every 24 or 30 inches or any distance required, like a check-row corn planter. With such a machine, half a pound of seed will sow an acre. At present with a continuous drill, one and one-half to three pounds are required, and since seed frequently costs two to three dollars per pound, there is unnecessary expense, both in seed and thinning. The plants should be thinned as soon as three or four inches tall, or when they have three or four leaves.

FIG. 12.—*Effect of brown-rot of cabbage.*

Although no experiments have been made in regard to the best time of sowing, the results have been quite satisfactory from sowing early in May. Later sowing, however, may give smaller heads which will keep better in storage. It will also probably give a smaller yield.

Planting.

For two years, experiments have been in progress to test the results from sowing the seed as above described and from transplanting. The results are not conclusive. Transplanting is best performed by one of the machines, made for the purpose.

Experiments extending over a period of three years, with 12 varieties, on deep or shallow setting of the plants when transplanting them,

show that some varieties did better when planted shallow, while others did better when planted deeply; but since the differences were slight and might readily be due to other causes the conclusion arrived at was that the depth at which strong and stocky cabbage plants are set does not influence the extent or weight of the crop (C. U. Report, 1891).

Thirty-inch rows or even thirty-six inches are preferred on the University Farm, because of the greater ease in using machinery. Such widths permit of clean culture and frequent and late intertillage. It is preferred to crowd the plants in the row to 24 inches if necessary, and have wide rows, and fewer to the acre, as by so doing the cost of growing is thought to be reduced. There should be from 7,500 to 9,000 plants per acre and no missing places.

Rotation.

Cabbages may be grown in place of corn or other intertilled crop in a short four- or five-course rotation. It would hardly be deemed advisable to put them on an old sod on account of the trouble from cutworms and wire-worms.

Varieties and Yields.

During the three years' trials four varieties have been grown, one of them, however, the Volga, for only two years. In addition to the varieties, a trial was also made of two dates for planting. The earlier date was practically the second week in May, when the seeds were sown in their permanent places and afterwards thinned. The latter date was practically the third week in June. For these plantings, plants were taken from the earlier sowings. The third year, the late planting was not made.

The following tables give the yields of fresh and dry substance, with percentage for each variety, during the period of their trial:

CROP OF 1904.

	Yield per acre, tons.	Per cent dry matter.	Dry matter per acre, tons.	Per cent sugar.	Sugar per acre, tons.	Number of plants, thousands.
Planted May 11:						
Surehead	51.2	7.60	3.9	3.05	1.6	7.7
Danish Ball	34.5	7.75	2.7	2.38	.8	8.2
Autumn King	44.1	6.90	3.	2.26	1.	7.7
Surehead	45.3	6.20	2.8	1.86	.8	9.
Average of all plats	43.8	7.11	3.1	2.39	1.	8.1
Average of Surehead	48.2	5.90	3.35	2.45	1.2	8.4

CROP OF 1904—*Continued.*

	Yield per acre, tons.	Per cent dry matter.	Dry matter per acre, tons.	Per cent sugar.	Sugar per acre, tons.	Number of plants, thousands.
Transplanted June 15:						
Surehead	31.40	6.87	2.16	2.42	.76	6.4
Danish Ball	25.60	8.42	2.16	3.27	.84	6.4
Autumn King	25.16	7.88	1.98	2.93	.74	6.4
Surehead	27.12	7.60	2.06	2.68	.72	6.4
Average of all plats	27.32	7.69	2.09	2.82	.76	6.4
Average of Surehead	29.26	7.24	2.11	2.55	.74	6.4

CROP OF 1905.

	Yield per acre, tons.	Per cent dry matter.	Dry matter per acre, tons.	Per cent sugar.	Sugar per acre, tons.	Number of plants, thousands.
Planted May 9:						
Surehead	27.5	5.74	1.58			7.
Autumn King	30.6	6.45	1.99			7.2
Danish Ball	26.9	6.39	1.72			7.1
Surehead	32.	6.30	2.02			7.3
Volga	30.8	6.36	1.96			6.8
Volga	27.3	6.16	1.70			7.
Surehead	27.	6.55	1.77			6.8
Average of all plats	29.	6.28	1.82			7.
Average of Surehead	28.8	6.2	1.79			
Transplanted June 20:						
Surehead	35.5	5.05	2.11			6.5
Autumn King	32.	6.51	2.08			6.7
Danish Ball	25.9	6.45	1.67			6.7
Surehead	34.3	6.43	2.21			6.7
Volga	26.7	6.52	1.74			6.8
Volga	31.1	6.21	1.93			6.8
Surehead	29.8	6.15	1.83			6.7
Average of all plats	31.	6.32	1.94			6.7
Average of Surehead	33.2	6.17	2.05			6.6

The soil upon which the crop of this season was planted was a rather heavy phase of Dunkirk clay loam. It seemed to be deficient in organic matter and the supply of available moisture was not always sufficient or constant. These factors tend to lower the yield for this season as compared with last.

CROP OF 1906.

	Yield per acre, tons.	Per cent dry matter.	Dry matter per acre, tons.	Per cent sugar.	Sugar per acre, tons.	Number of plants, thousands.
Planted May 16:						
Surehead.............	23.4	8.62	2.02			7.
Autumn King.........	21.3					7.
Danish Ball...........	20.5					7.
Surehead.............	26.1	9.48	2.47			7.
Volga.................	19.8	9.63	1.91			7.
Mammoth Drumhead...	24.8					
Surehead.............	21.7	8.55	1.86			7.
Average of all plats...	22.5					7.
Average of Surehead..	23.7	8.88	2.12			7.

These figures bring out several facts worthy of note. In yield of both fresh substance and dry matter, the earlier planting produced the best. There is no doubt but that dropping the seeds in their permanent places is the easiest way of planting when transplanting machines are not used. It may be, however, that by this method more care and work are required in thinning and cultivating. Nevertheless, it is important that the plants have a long growing period and that they receive no check in growth. As to the varieties, all were good. Volga leads in the proportion of head to total plant, and it kept better than Surehead or Autumn King. Autumn King seemed to be better suited to clay loam soil than to gravel loam. Surehead did better than Autumn King in 1904 on gravel loam. Danish Ballhead is the lowest in yield, but has compact head, see fig. 14.

Essentials of a High Yield.

First, rotation. It matters little what crops be grown, provided they are in accordance with rational practice, the main point being that when cabbage crops follow each other in succession the soil is likely to become infested with the club root fungus which will render it unfit for

growing cabbage for a number of years. Second, early planting. This gives time for full growth and development of the heads. Third, uniform stand. The number of plants per acre may vary between seven and ten thousand. As with many other tilled crops, however, it is more essential to have the largest number of plants possible in the rows, and the rows wide enough apart to permit free use of horse implements in tillage. This may cut down the number of plants per acre, but it will be economical in the end.

General Treatment.

The plants must never receive a check. Three or four days after transplanting or after thinning, they should receive an application of 50 pounds of nitrate of soda per acre; this may be applied near the rows

FIG. 13.—*Heads which burst are useless for sale. They do not keep well in storage.*

with a drill if feasible, or be sown broadcast and harrowed in at some time when the leaves of the plants are dry, for if they are wet and it dissolves on the leaves it will burn them. This application may be repeated twice more, at intervals of ten or fourteen days, making a total application of 200 pounds of nitrate of soda per acre; even 300 pounds may frequently be used with profit. No crop will give better returns for such

treatment and for clean and constant culture. The nitrate of soda adds leaf growth at a time when one green worm may eat a cabbage a day, and forces them through this critical period.

Clubroot or Anbury is a fungous disease which attacks many cruciferous plants, and is common among turnips, causing them to rot badly. It can be readily combatted by liming the land at intervals of four or five years as suggested (page 24) by destroying all cruciferous weeds; and by arranging the rotation so that such crops will not be taken too frequently.

Black-rot or stem-rot is a bacterial disease and is one of the most disastrous troubles of the cabbage. It is often found on wild mustard and other cruciferous weeds which act as hosts in spreading it. There is no cure. Prevention by means of disinfection of seed, destruction of diseased specimens, a good rotation and the control of insects which may carry the germ are suggested. A diseased crop should not be stored; better sell the good plants while they are good.

The Flea-bettle.—A small, black, quick moving insect, sometimes destroys the seedlings while they are in their first leaves. The best means of combating is to sow plenty of seed and thin.

The Green Cabbage-worm.—While the plants are small the green "worms" or caterpillars do serious injury. This must be prevented or the crop will be ruined. If boys can be secured, hand-picking early in the morning for about three weeks while the plants are young, may be advisable. The importance of killing the first spring brood needs emphasis. During the year 1904, attention to this saved further trouble. The first brood becomes mature in two or three weeks and would perpetuate the trouble all through the season. They may be combatted by spraying with arsenate of lead in water or some other arsenite while the plants are young, but it is not advised for plants nearing maturity; for the latter pyrethrum or hellebore is suggested.

The Cabbage Looper frequently does considerable damage and is dealt with in the same way as the green-worm.

Cabbage Root-maggot sometimes injures the roots (Consult Bull. 78).

In the southern states the Harlequin Cabbage-bug does considerable injury. It is checked by sowing mustard and radishes earlier in the cabbage fields for the bugs to congregate on and then destroying these by spraying with kerosene.

Cabbage Aphis.—No trouble was experienced during 1905. In former years aphis or "green fly" has caused trouble on the farm; the following extract is from the volume containing the report of experiments made at this Station between 1879 and 1880:

> "Aphis brassicæ (the cabbage-louse) completely covered the free leaves of most of the cabbages and rutabaga turnips in this region

and has not yet been successfully treated. Their minute black eggs are abundant on the cabbage-stumps and leaves left in the field, so that we may expect a grand crop of lice next year. All the parts of the cabbage which are not eaten should be consumed by fire to kill the hibernating eggs. The little males, which differ from the wingless females, appeared in great numbers later in October, when the eggs were being deposited."

In 1904 the aphis which attacked the rutabagas was controlled by spraying with whale-oil soap solution, using one pound of soap to six gallons of water, and although this was done but a few weeks before harvesting the crop, stock did not object to the roots. Kerosene emulsion or tobacco might have been used.

Uses of Cabbages.

Their particular value seems to be to furnish succulent and easily digestible feed for dairy cattle, sheep and other stock from August until November, or at the time the pastures are failing. They have an additional value since they may be sold as a cash crop if cabbages are scarce, and in such case it may be deemed advisable to store them.

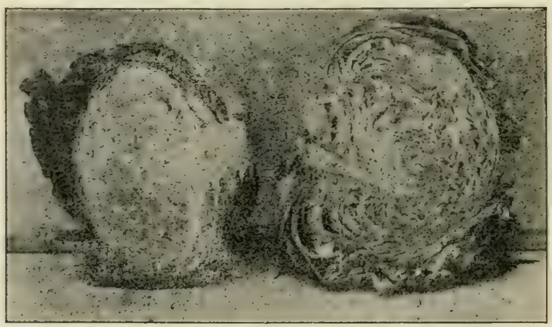

FIG. 14.—*Danish Ballhead, round, close and firm in texture. Keeps well in storage. Surehead (at right), light, open in texture, does not keep well in storage.*

During the past two years the percentage of dry matter of cabbages has varied from 5.74 per cent. to 8.42 per cent., in all cases being lower than the figures usually given and used in calculating rations. The actual yields of dry matter per acre varied from 1.6 to 3.9 tons. About one-fourth of this nitrogenous matter and cabbages are looked on as being rich in protein.

Methods of Feeding.

Cabbages are good food for cattle, sheep and swine. When they are grown for stock feeding it has not been a general practice to remove

them from the field. If it is convenient for feeding to continue into early winter they are pulled and piled closely, then fed directly from the field. When fed to sheep they are generally not cut. The sheep can nibble them very well. When fed to cattle they should be cut either by a cutting machine, or they may be chopped fairly well with a square-pointed shovel. They should be fed as soon after being cut as possible. Sometimes the grain or chopped feed is mixed with them.

It is claimed by many feeders that cabbages are likely to lend a disagreeable odor or taste to the milk when fed to dairy cattle. This may be avoided, however, by feeding just before or just after milking, care being taken to remove the milk from the presence of the cabbage as soon as possible.

Marketing.

There is one difficulty which may be encountered in trying to sell a crop of cabbages which has been grown for stock-feeding. Such heads are usually large, averaging 10 pounds and running to 20. The public want to buy a cabbage for five cents. This, in years of good price, limits the size of the head to about four or five pounds. A ten-pound cabbage costing ten cents is too large because it cannot be used, so that the sale is limited. The man who is growing cabbages for sale, therefore, must either crowd the plants or, by sowing a little later, secure heads weighing only four to six pounds. Of course, if grown for sauerkraut-making and sold by the ton, this feature would not be important.

Storing.

Cabbages should be left in the field as long as possible, but it is better to harvest a week too early than a week too late. They must not be stored when wet or handled when frozen. Cabbages which are bruised when frozen are invariably spoiled and will not store. An immature crop, one in which the heads are undersized, should not be regarded as a failure, but it should be stored as described for storing seed cabbage, page 31. In this way the head will develop and the most be made of it. Heads which have not quite reached maturity are the best for storage.

Method I. One of the simplest ways is to store in an orchard or some sheltered place, often alongside a fence which has been made tight by a liberal use of straw. The cabbage are stored with their stems on and are placed head down and as close together as possible. Two or three tiers are often made, the heads of the second tier being placed between the stems of the lower, and so on, the piles being made of any width and length desired. The whole is covered with leaves, salt hay or straw and a little soil, rails, brush or litter. Small unsalable heads

when stored in this way in November will continue to develop during winter and frequently sell as well as any in February.

Method 2. Small quantities may be stored by plowing out two or three furrows, 10 or 12 inches deep, on a well drained site, and placing the heads with their stems up, as close together as possible; some prefer to lay them but one or two thick, while others will pile them up two to two and one-half feet high, bringing them to a point. The pile is then covered with straw, salt-grass hay, or a thin layer of straw and then several inches of soil. They are stored before freezing; and when the soil covering them is frozen it may be covered with strawy manure or any other litter to keep the soil frozen until the cabbages are needed for sale.

Method 3. Large quantities are stored in cabbage houses, this being the best way, commercially, for a large part of the State. The houses are often built alongside the railroad in order to facilitate shipment, but a small one can be built on the same principle if desired. The walls are frequently about eight feet high at the eaves, built with three walls and two air spaces papered on the outside, with a close-boarded and tar-papered roof. The building may be 50 feet wide and of any desired length, with a driveway through the center and well provided with ventilating arrangements. The building is divided into compartments or bins, which run across the house, from the driveway to the wall, one on each side. These are five feet wide, made of slats on four-inch studding; this permits of a four-inch air space all round each bin, the end near the outside wall included. The floor of the bin is raised from the ground about ten inches and is also made of slats, thus securing free circulation of air. When the bins are filled, the driveway may be filled if desired. The heads are cut close, practically ready for shipment, and are piled in the bins, from the floor to the ceiling. The filling is done in cold weather, if possible, and care is required in ventilating to keep the temperature of the building as near 30 degrees to 35 degrees as possible, opening during cool nights and keeping it closed on warm days or when cold snaps occur.

Method 4. One or two car loads may be stored in the following manner: Select a dry site, excavate about one and one-half feet deep and nine feet wide and of the desired length. Set posts in each corner and every four or five feet along the side, letting them project about four feet above the ground level. Board up the inside, 16 foot boards being useful. Set 2 x 4 inch rafters on the studding, and roof with wide boards, lapping them a little. Cover the apex of the roof with two boards, fastened together like an inverted V. Bank up the outside of the house, and in cold weather cover the roof with straw or horse-manure.

Storing seed cabbage.—In storing cabbages which are to be used for seed production, it is important to save the roots, hence these receive first

consideration. C. L. Allen advises (Cabbages, Cauliflower, etc.) that a deep double furrow be plowed on a well drained piece of land and that in this the cabbages be placed roots down. This will hold three rows of cabbages, two rows being laid on the sides and the third between them (Fig. 15). As fast as they are placed, the roots are covered with soil which is packed firmly over them. When the furrow is filled, the cabbages are covered with soil by plowing a furrow on each side. When the soil is frozen it is covered with litter or manure to prevent freezing of the cabbages.

Seed Production.

The important points in a cabbage are uniformity in size; a minimum of outside leaves to head; a small percentage of stump to leaf when the head is cut open; a firm head, the leaves being closely packed together; freedom from evidence of disease or insect injury; and true to name and type if such are recognized and described. Such heads should be selected in the field in the fall, carefully lifted and stored as described.

The cabbages may be planted as early as possible in spring on some rich and well-prepared ground, being set about three and one-half or four feet apart each way. In some cases the ground is mulched with manure after planting and no culture is given, other than to chop off a weed should one appear. Two varieties should not be planted near together, since the evidence shows that, if they bloom at the same time, they may cross-fertilize. Some other cruciferous plants will cross-fertilize with heading cabbages.

FIG. 15.—*Method of storing cabbage for seed. By this means the roots are protected.*

Birds attack the seeds as soon as they begin to ripen and particularly if cabbages are grown in small quantities. To guard against such ravages, it may be necessary to cover the plants with netting. As soon as the bulk of the seeds are approaching maturity the stalks are cut, tied up in bunches and hung in the barn or in some well ventilated place where they can be protected from the birds. As soon as the seeds have matured they may be threshed. A small quantity may be threshed on a sheet by hand, using a stick or light flail. Since seed is so easy to secure, and so expensive to buy, it seems that it would be policy for farmers to save their best plants and grow seed every alternate year, growing sufficient for at least three seasons. Ten plants may be expected to yield one pound of selected, cleaned and first-class seed, and in some cases one plant has given considerably more than this.

LIST OF CO-OPERATIVE EXPERIMENTS FOR 1907.

The following schedule gives a list of the demonstrations or experiments that it is proposed to offer to New York farmers in the season of 1707. These experiments cover some of the most important of the newer problems that are just now pressing themselves on the attention of our farmers. The list contains enough subjects to offer to every farmer one or two for his particular study. We desire to correspond with any person in the State who may wish to take up any one or more of these subjects on his own place.

We will be glad to also hear from any farmer who desires to conduct experiments not here listed and to give such aid as may be possible.

There are two purposes of co-operative experiments: (1) to teach; (2) to discover new truth.

1. The gradually changing soil conditions as our lands become older, the rapidly changing prices of labor and farm produce and the constant discoveries of new scientific facts make it necessary that the farmer be ever alert, and ready to change his farm practice to meet the constantly changing conditions. To meet these conditions there is a growing tendency among farmers to experiment. These trials are sometimes made by such imperfect methods that the wrong conclusions may be drawn. The first purpose of co-operative experiments is to encourage such trials by methods that are accurate but not complicated,—to set each man to working out his own problems, to bring him in touch with the latest results of experiment station work in order that he may test these results and determine whether they may lead to a more profitable method of farming his land.

2. The second but equally important object of this work is the discovery of new truth, either in determining how wide an application the results of experiment station work have, or in solving problems that from their nature cannot be worked out at the experiment station. Each farmer who reports on an experiment thereby contributes to this increased knowledge of agriculture.

These demonstrations and experiments are in eight divisions, each division in charge of a specialist: I. Agronomy, G. F. Warren; II. Plant Selection and Breeding, J. W. Gilmore; III. Horticulture, L. B. Judson; IV. Entomology, M. V. Slingerland; V. Animal Husbandry, H. H. Wing; VI. Poultry Husbandry, J. E. Rice; VII. Dairy Industry, R. A. Pearson; VIII. Plant Diseases, H. H. Whetzel. Correspondence should be addressed to the persons who have charge of these branches at Cornell University, Ithaca, N. Y. Specify by number the experiments in which you are interested.

The general plan of work is mutual or co-operative,—the farmer to provide land and labor, the expert to give advice and supervision and, so far as possible, to inspect the work. In a few cases where seed and materials cannot be readily purchased, they are furnished by the college. The person on whose farm the experiment is made will receive most of the benefit but we desire reports from each man so that the results may be given to others.

It will be impossible, of course, to serve everyone. We shall take only as many experiments as we think we can handle satisfactorily. Persons who desire to engage in this work must apply quickly. Full instructions, together with blanks for the making of reports, will be sent to applicants.

AGRONOMY OR FIELD CROPS.

G. F. WARREN.

One of the most important problems that confronts the New York farmer is the growth of feeds that are high in protein. Nearly all farmers produce enough carbohydrates for feeding their stock, but few produce enough protein. Corn, timothy hay, straw and mixed hay all contain a small proportion of protein. To supply this deficiency, large quantities of feeds high in protein are purchased each year. Those who wish to try to grow feed to replace some of the purchased feeds will do well to try one or more of experiments numbers 101 to 109.

The following table gives the number of pounds of digestible protein for each pound of digestible carbohydrates (+ 2¼ times fat) in a few feeds. This is called the nutritive ratio. A ratio of 1:6 means that the feed contains 6 pounds of digestible carbohydrates (or equivalent in fat) for each pound of digestible protein. A good ration for cows ordinarily contains protein and carbohydrates in about this proportion. It will be seen that the first five feeds contain enough or more than enough protein while the last five do not contain nearly a large enough proportion of protein:

DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100 POUNDS

	Dry matter.	Protein.	Carbohydrates + 2¼xfat.	Nutritive ratio.
Alfalfa hay	92	11.0	42.3	1: 3.8
Wheat bran	88	12.2	45.3	1: 3.7
Red clover hay	85	6.8	39.6	1: 5.8
Oat and pea hay	85	7.3	38.2	1: 5.2
Mangels	9	1.1	5.6	1: 5.1
Soy beans and corn silage	24	1.6	14.6	1: 9.2
Corn silage	21	.9	12.9	1:14.3
Corn stalks (no ears)	60	1.7	34.0	1:20.0
Timothy hay	87	2.8	46.5	1:16.6
Oat straw	91	1.2	40.4	1:33.7

As will be seen from the above tables, alfalfa has about the same composition as wheat bran. It is a little more difficult to digest so that it is not worth as much per ton as the bran. It is a much more valuable hay than red clover and when successful yields much more per acre. It grows best on porous, well drained soils, but with proper treatment it is successful on many soils that are not particularly well adapted to it. There are successful fields in nearly all parts of New York State. In order to determine whether a farm will grow it successfully it is best to try several different treatments. Many farms where it has been tried can unquestionably grow it successfully and on some soils where it has been tried and failed it can undoubtedly be grown if given proper treatment. It is such a valuable feed that one can afford to try a number of different treatments before giving it up. Experiments 101 and 102 are designed for those who wish to determine the best method of growing alfalfa on their farms.

101. *Alfalfa.*—A test of several soil treatments in order to determine if alfalfa can be grown on the experimenter's farm and to determine what treatment should be used. Full directions for making such a test, based on knowledge obtained from previous experiments will be furnished by the college. The experimenter to report the results from each treatment..

102. *Alfalfa: Time of seeding.*—A comparison of spring seeding with summer seeding, about August 1.

103. *Alfalfa: Inoculation.*—A test of different methods of inoculation.

104. *Alfalfa.*—Variety test.

105. *Peas and oats.*—A trial of "Canada" field peas and oats for soiling hay or grain and straw. In some parts of the State these are being quite extensively grown and with good success.

106. *Rye and vetch.*—A test of the value of rye and winter vetch as a soiling crop for early summer feeding or as a cover crop to be plowed under for soil improvement. Winter vetch is a very promising legume for either of these purposes. About a pint of seed will be sent to each experimenter. This is not enough to make a very careful experiment but the experimenter can watch its growth and see how favorable it appears. Those who wish to make a trial on a larger area will be furnished with addresses where the seed may be obtained.

107. *Soy beans in corn.*—A test of the value of soy beans as a means of increasing the per cent. of protein in silage.

108. *Red clover.*—For farms that once grew clover but now fail to do so. A test of different soil treatments in order to determine, if possible, what method will succeed in producing clover.

109. *Mangels.*—A test of mangels as a partial substitute for purchased concentrated feeds.

Some experiments have seemed to show that a pound of dry matter in mangels has about the same feeding value as a pound of grain feeds. Mangels may be looked upon as equivalent to the concentrates plus water. At this experiment station in 1904-5 they have given over twice as much feeding value per acre as the same land would produce in corn. The labor required to grow them is considerable. Mangels have a special value to those dairymen who do not have silos as they add a needed succulence to a ration that is ordinarily too dry. A porous soil that is well manured and free from weeds will produce the best crop at the least labor expense. Directions for making a trial of mangels based on the variety and cultural trials at the college will be furnished. The farmer to report his yield and success with them.

110. *Renewal of pastures and meadows without plowing.*—The best way to renew grass land is to farm it a year or more and then re-seed, but with the present high price of labor and low price of land, it is in many cases desirable to make an effort to improve the pasture or meadow without plowing. There are also pastures that cannot be plowed, that might be considerably improved.

111. *Grass mixture.*—Trial of a grass mixture for new pastures that are to be permanent.

112. *Summer seeding for pasture or meadow.*—A comparison of spring seeding with seeding after the removal of small grain or other crop.

113. *Rate of seeding for meadows.*—Comparison of three different amounts of seed per acre for a meadow.

114. *Fertilizers for meadows.*—Experiments at the college have shown that certain fertilizers may be used to profit in growing hay on our soil. The college will furnish fertilizers ready for application to a limited number who will agree to apply them to four measured plots 1 x 4 rods each, and weigh the hay produced on each plot, and report results. The hay may be weighed with a spring balance. The trial to be made on a meadow that has a good stand of grass. Those who wish to make a trial on a larger area will be given directions for the purchase and use of larger quantities of the same mixtures.

115. *Fertilizer trial of any crop.*—The object of this test is to determine what fertilizer is most profitable on the farm of the experimenter. The set of fertilizing materials will cost about $4.00.

116. *Under drainage.*—The crop producing power of many New York farms can be greatly increased by tile drainage. Those who are interested in this question can secure bulletins on the subject and we will be glad to hear of the results of the operation.

117. *Lime requirement of soils.*—A test of soil with litmus paper to determine whether lime is probably needed. This is to be followed by a trial of lime on a small plot. The proper kind of litmus paper and directions for the trial will be furnished.

118. *Spraying for wild mustard.*—Mustard can be easily killed by proper spraying with copper sulphate or iron sulphate.

119. *Cost and profit or loss in the production of any crop.*—Duplicate blanks for keeping account with the corn, oat, or wheat or other crop will be supplied. One copy to be returned to the college.

120. *Reduction of labor by use of more horses per man.*—Under some conditions a saving can be made by having each man drive more horses. This is a matter that cannot readily be arranged as an experiment, but correspondence is desired with those who feel that their conditions warrant a trial of this subject and reports of the success or failure of such efforts are desired.

121. *Potato cultural test.*—The college has obtained good results in growing potatoes by what has come to be known as the Cornell method. Many farmers have likewise increased their yield by this method. It gives best results on gravelly or sandy soils.

122. *Buckwheat:* Cultural test.—Plow one plot early and harrow frequently until seeding time. Till other plat in the customary way.

123. *Crop rotation.*—A comparison of the present system with one that contains more legumes. This experiment must run several years in order to secure results.

II. PLANT SELECTION AND BREEDING.

J. W. GILMORE.

124. *Potatoes.*—An experiment in selection by hills for the purpose of increasing the yield.

125. *Corn.*—An experiment in selection and breeding with a view to developing an improved strain. (1) For silage or (2), for grain.

126. *Oats.*—An experiment in selection by individual plants for the purpose of increasing the yield.

127. *Wheat.*—An experiment in selection by individual plants for the purpose of increasing the yield.

NOTE.—Detail of methods furnished to interested parties.

III. HORTICULTURE.

L. B. JUDSON.

30. *Orchard cover crops.*—3 plats. A comparison of the values of hairy vetch, Canadian field peas, and mammoth clover, in apple, plum,

pear or peach orchard. All plats in cover-crop experiments 1/8 acre in extent. Keep soil thoroughly stirred from spring until middle of July, when seed should be sown. Seed furnished by the college.

31. *Mulching versus cover-cropping.*—A comparison of these two methods in the same orchard is wanted, to show the effect on yield, color, and size of fruit. This will make an interesting experiment with any kind of tree fruits, but apple and pear orchards are especially desired. This line of experimentation is one of the most interesting, important and practical now before fruit growers in this State, and any capable grower may readily obtain valuable results. Particulars sent on application.

32. *Spraying experiment.*—Compare the effect of ordinary Bordeaux mixture (4–4–50) with the weaker mixture (3–3–50) which we shall recommend this year, both as to control of scab and amount of spray injury. In mixing the Bordeaux, always put in water between the other two materials. See direction in the recent Spray Calendar.

33. *Nursery stock experiment.*—Fumigation of nursery stock seems frequently to be either ineffective in destroying insects, or injurious to the trees, and it is very desirable to know whether dipping the trees completely in warm lime-sulfur wash and thus insuring destruction of scale will prove injurious to the trees. Have the nurseryman do the fumigating if you have not the conveniences,—and the dipping, too, if you wish. Plant an equal number of each kind in adjoining rows, and compare the growth for the first season. Write for details.

34. *Spraying to prevent peach and plum rot.*—Ammoniacal copper carbonate against dilute Bordeaux mixture. Spray twice as fruit is ripening. Spraying material furnished by the college.

35. *Thinning fruit.*—Conduct tests on early apples, peaches, and plums. Write for details.

36. *Strawberries and raspberries.*—Test the varieties, both standard and new.

IV. ENTOMOLOGY.

M. V. Slingerland.

41. *Poison sprays for plum and quince curculios.*—Experiments with arsenate of lead and arsenite of lime sprays. Specific directions and arsenate of lead furnished by the college. Desire to co-operate with peach growers especially in experiments against the curculio.

42. *Spraying for grape root-worm.*—Experiments with arsenate of lead spray to poison the beetles. Specific directions as given in Bulletin 208 or the Spray Calendar. (Bul. 217.)

43. *Spraying and timely cultivation for the rose-chafer.*—Specific advice in regard to time to cultivate to kill the pupæ, and directions given for spraying with arsenate of lead to kill the beetles. Poison furnished by the college.

44. *Spraying for oyster-shell bark-scale and scarfy bark-scale in June* with soap or oils. Specimens desired at intervals of a week beginning about June 1st to determine date of hatching of eggs in different parts of the State. Experiments to begin as soon as the eggs hatch.

45. *Oil Sprays for the San José scale.*—Experiments with the so-called soluble oil sprays. Specific directions given and part of material furnished by the college.

46. *Fumigation of mills for grain pests.*—Specific directions and personal aid given each infestation and part of fumigation materials furnished by the college.

V. ANIMAL HUSBANDRY.

H. H. WING.

50. *Cattle.*—The information sought will include (a) period of gestation of cows, (b) sex of offspring, (c) weight of offspring at birth, (d) in case where calves are raised or vealed weight at four, six and eight weeks of age. To those who undertake this work cards for making reports will be furnished on request.

51. *Swine.*—The information asked for will include (a) period of gestation, (b) number of offspring, (c) sex of offspring, (d) weight of litter and if possible of each individual at birth. To those who undertake this work, cards for making reports will be furnished on request.

VI. POULTRY HUSBANDRY.

J. E. RICE.

60. *Importance of supplying grit to fowls* to determine the amount consumed, the best kind, and the effect upon the quantity of eggs, hardness of shell, and in preventing "egg eating."

61. *The importance of meat in a ration for egg-production,* and to observe the effects upon number, size and fertility of eggs and vitality of chickens.

62. *The value of a ration of whole grain* as compared to the same ration part of which is ground and fed dry or fed in a "hot mash."

63. *Comparative value of hot mash* and the same feed fed dry.

64. *Breed test.*—A comparison of pens of the same number of individuals of different varieties of similar age.

65. *Making observations and post mortem examination to determine the cause and cure of white diarrhea in chickens.*—List of questions and illustrations will be sent upon application.

66. *Feeding chickens whole grain versus soft food,* or rations with and without some form of meat or skimmed milk.

68. Weigh all the food which a flock of fowls consume during one or more weeks. Keep a record of the eggs laid each day and the age, variety and number of hens in the flock. Send report on blanks which we furnish on application and if it is desired, we will figure the nutritive ratio and cost of the ration, and will suggest changes if necessary.

69. Send measurements of poultry houses, giving length, breadth, height to plate and ridge. Figure the square feet of floor space, cubic feet of air space, square feet of window opening: number and kind of fowls enclosed. Draw end view, front view, ground plan and show construction of walls, kind of roof, straw loft, etc. Blank forms will be furnished.

VII. DAIRY INDUSTRY.

R. A. PEARSON.

80. *Churning.*—To churn cream from fresh and stripper cows to determine best methods of handling the cream from cows far advanced in the period of lactation.

81. *Small-top milking pails.*—To determine their practical advantages and disadvantages.

82. *Period of ripening.*—A comparison of long and short periods of cream ripening.

83. *Washing cream.*—The effect of this treatment upon the flavor and grain of butter.

84. *Whey butter.*—Best methods of handling whey and cream for making whey butter.

85. *Sanitary dairying.*—To determine cost in labor and cash outlay necessary to improve the sanitary condition of a dairy, using score card to report conditions existing.

86. *Over-run in churning.*—To determine effect of temperatures of churning and temperatures of wash water.

87. *Variations in the composition of milk.*—To determine effects of different conditions upon the fat content of milk.

88. *Small sized cheese.*—A test of the market demand for small cheese.

VIII. PLANT DISEASES.

H. H. WHETZEL.

90. *Loss from corn smut.*—To determine the loss from any given field to determine if it will pay to eradicate smut from corn fields.

91. *Loose smut of wheat.*—Special hot water treatment of seed wheat to determine to what extent smut in the succeeding crop may be reduced.

92. (a) *Bean anthracnose or pod spot.*—Experiments to determine the value of planting clean seed as a preventive of this disease.

(b) Spraying with Bordeaux mixture to determine its value as a preventive of this disease in field practice.

93. *The feeding of copper sulphate to plants as a preventive of fungus diseases and also as a stimulus to growth and production in the host.*

94. Plans for treating fungus diseases in any crop in which you are interested will be prepared if possible and furnished upon application.

DECEMBER, 1906 BULLETIN, 243

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Agronomy

ROOT-CROPS FOR STOCK-FEEDING

Made under the direction of Thomas F. Hunt

By SAMUEL FRASER, JOHN W. GILMORE AND CHARLES F. CLARK

ITHACA, N. Y.
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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

ROOT-CROPS FOR STOCK-FEEDING.

For three seasons the Cornell Experiment Station has conducted a series of investigations on the desirability and methods of growing various kinds of roots for stock-feeding, and to determine the varieties best adapted to this purpose. This bulletin deals with mangels, sugar-

FIG. 16.—*Long Red mangel. A variety producing a large root and a heavy yield. Easy to harvest, with few rootlets; it is very succulent.*

beets, turnips, hybrid turnips, rutabagas, kohlrabi, carrots and parsnips. It is intended to contain such information as may be necessary to guide those who wish to raise any of these crops under New York State conditions. The growing of a number of different types and varieties of roots has contributed the information. A similar bulletin on cabbages

has already been issued (No. 242). One on varieties and culture of root-crops is to follow (No. 244). It is hoped that these three bulletins will enable the farmer to decide under what conditions it may be advis-

FIG. 17.—*Sutton Long Red mangel. One of the best yielding varieties. Shape long and flesh usually solid. For yield see pp.* 106, 111.

able for him to raise these palatable and highly digestible forms of food for his domestic animals.

Ten types of root-crops have been grown at the Cornell Experiment Station, including over fifty varieties, in the seasons of 1904, 1905 and 1906. The object of this test has been to determine: (1) whether root-

crops may be economically raised as a substitute for western grains (but not as a substitute for silage or dry roughage), especially for the more northern parts and higher altitudes of the State; (2) if so, which type and which variety of that type is best suited to New York conditions; (3) the best cultural methods.

Concentrates vs. Roughage.

The reason why the production of roots is of special interest in the North Atlantic States is that these states raise a comparatively large amount of roughage and a small amount of concentrates, while the North Central States raise a large amount of cereals or concentrates in proportion to hay and forage as shown in the following table.

The following table shows the ratio of concentrates to roughage in the North Atlantic and North Central States according to the Census of 1900:

	North Atlantic.	North Central.
All cereals except wheat, million tons	4.4	69.2
All hay and forage, million tons	15.6	49.0
Per cent. of cereals except wheat	22.0	58.5
Tons cereals except wheat, per animal unit	.55	1.55
Tons hay and forage per animal unit	1.95	1.10
Total tons of food per animal unit (of about 1,000 lbs. live weight)	2.50	2.65

The significance of this table is further emphasized when the superior feeding value of concentrates is fully understood. For example, experiments made by Zuntz of Germany, show that when clover hay was fed to horses, 41 pounds were digested out of each hundred pounds of hay fed, while, when oats were fed, 62 pounds were digested, or 50 per cent. more.[1] It was found, however, that it required the energy of 24 pounds of the 41 pounds of hay digested to supply energy to chew and digest the hay, leaving the net nutritive value at 17 pounds. On the other hand, it required only 12 pounds of the 62 pounds of oats to masticate and digest the oats, leaving 50 pounds of oats available for producing energy or work. In other words, the oats had three times the value of the clover hay for the production of work in horses. The energy used

[1]Landw., Jahrb, 27 (1898), No. 3, pp. 440; pls. 7, fig. 1 (E. S. R. XI, 72).

FIG. 18.—Eckendorf half-sugar white mangel. Upper row early sown; lower row late sown. A good type to grow. They do not vary in yield so widely as do regular mangels and they yield well in dry matter.

FIG. 19.—Half-sugar mangels. A good type to grow. They do not vary widely in yield. They yield well in dry matter. They are easy to harvest.

up in chewing and digesting food is manifested in heat and helps to keep the animal warm, and is therefore not entirely lost when the ration is merely for maintenance. But since in any liberal feeding for the production of work, the production of meat, or of milk, the amount of heat thus produced is sufficient to keep the animal warm, the figures given above may be taken as representing their true food value.

Value of mangels for milk.

Rather extensive Danish experiments indicate that a pound of dry matter in roots is about equal to one pound of the cereal grains, or to three-fourths of a pound of cottonseed meal, when fed to milch cows.[2] In these trials no silage was fed, the basal ration in each case consisting of six and one-half pounds of hay and 10 pounds of straw per cow. The experiment was so conducted as to eliminate apparently the factor of succulence as shown by the following table:

Average of six experiments including about 150 cows during several months. Basal ration six and one-half pounds hay, 10 pounds straw.

	Cereal grains.	Cotton-seed meal.	Dry matter in root mangels.	Nutritive ratio.	Daily yield of milk.
	Lbs.	*Lbs.*	*Lbs.*		*Lbs.*
Lot A	7	1.5	4.5	1:8–9	22.4
Lot B	4	4.5	4.5	1:5–5.5	23.7
Lot C	4	1.5	7.5	1:8–9	22.5
Lot D	1	4.5	7.5	1:5–5.5	24.2

It will be noted that all the cows were fed roots, but two lots were fed roots containing seven and one-half pounds of dry matter, equal to about 65 pounds of fresh roots, instead of four and one-half pounds of dry matter, equal to about 40 pounds of fresh roots. The additional three pounds of dry matter in the first-mentioned cases gave as good results as an equal quantity of cereal grains, the cereals consisting either of Indian corn or of a mixture of barley, oats, and rye. Roots, like the cereals, are highly digestible, perhaps even more digestible than the cereal grains, and herein probably lies their high value. From the standpoint of the results which they produce, the roots may be looked on as watered concentrates. They have apparently a high net available energy.

[2] Fifty-three Ber. Kgl. Vet. Landbohöjskoles Lab. Landökon. Forsög (Copenhagen), 1902, pp. 30. (E. S. R. XIV, 801).

The yield of dry matter.

One of the objections to roots as a food product lies in the fact of their high water content. This limits the quantity which may be fed and becomes of special importance where they are fed in connection with silage. On account of this high water content it will not be practicable to feed a sufficient amount entirely to take the place of the cereals, even should this be desirable for other reasons. The trend of experimental evidence is that the feeding value of the different types and varieties of root-crops depends more largely on the percentage of dry matter than any other factor; for example, the percentage of dry matter apparently modifies their feeding value more largely than the percentage of sugar.

The problem in New York State is whether we can afford to raise roots, and if so, what kind. The following table shows the minimum, average and maximum number of pounds of dry matter per acre which was obtained at the Cornell Experiment Station in 1904, 1905 and 1906 from sowings made in May:

	Minimum.	Average.	Maximum.
Mangels	2168	5155	8453
Half-sugar mangels	5480	5880	6440
Sugar-beets	6014	7090	8090
Rutabagas	3537	4331	5079
Hybrid Turnips	2584	3694	5111
Common Turnips	1710	2680	3500
Kohlrabi	3570	4070	4540
Cabbages	4076	4662	5588
Carrots	1878	3134	4379
Parsnips	2080	3130	3680

The estimated yield of grain from flint corn the same seasons at this station was approximately 2,000 pounds, while the yield of dry matter in silage from dent corn was about 4,000 pounds. It is probable that the season of 1904 was relatively favorable to the production of roots as compared with the Indian corn, but this was not true of 1905 and 1906. In the latter years the average yields from roots were better than in 1904, although the land used was conceded by all interested to be less favorable than that used in 1904.

Roots vs. cereals.

The present high price of cereals is a factor in favor of the production of root-crops. If corn-meal continues to be worth $20 a ton or more in New York State, economy in the production of roots would be indicated, while if the price should fall to $10 a ton, corn-meal would probably be the cheaper source of concentrates. The serious handicap to the raising of root-crops is the fact that with present cultural methods a large amount of hand labor is required. The point of view that is desired here to emphasize is that while roots may not be economically raised as a substitute for silage or other coarse fodders, it may be economical to raise them in New York State as a partial substitute for concentrates, particularly the cereal grains.

THE EXPERIMENT OF 1904.

Part of the land selected had been in mangels for three years, and is designated "no rotation area"; the remainder had been in other crops and in 1903 was in corn. It is designated the "rotation area." The land is slightly rolling and the soil is Dunkirk gravelly loam.

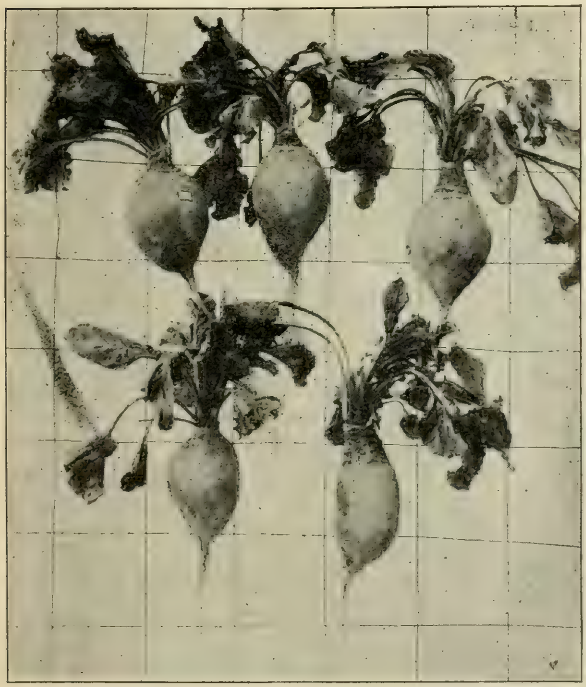

FIG. 20.—*Carter Red Emperor mangel. Ovoid in shape. Upper row early sown; lower row late sown. The yield of fresh substance and dry matter is rather low but they are better adapted, perhaps, to the shallow soils than the long kind.*

In most cases twenty-one rows of a particular type of root were grown in a section. These were divided into seven plats of three rows each. A variety occupied three rows or one plat. A seven-plat section permits the trial of five varieties: one variety being sown on the first, fourth and seventh plats as a check, and four other varieties being sown on the second, third, fifth and sixth plats. The

rows varied in length between 60 and 70 feet. They were 27 inches apart. The plats were a little over one-hundredth of an acre in area.

The original plan comprised ten sections, the first, fourth, seventh and tenth being mangels which were used as a check, the remainder being devoted to other roots. The roots under trial were mangels, half-sugar mangels, rutabagas, carrots, parsnips, cabbages, hybrid turnips, common turnips and kohlrabi.

A rectangular piece of land being chosen, it was divided lengthwise and half of it was sown early in May, the remainder being sown the middle of June, with the object to ascertain the influence of early and late sowing. On the "no rotation early sown" area the mangels were attacked by leaf-spot while young, with disastrous effect, see pp. 56, 58. The elevation is 836 feet above sea level. In 1904, there were 71 clear days, 115 partly cloudy and 180 cloudy days. It rained on 166 days. The total rainfall was 30.04 inches. This is 4.33 inches below normal. The total snowfall (unmelted) was 75.8 inches. The prevailing direction of the wind was northwest. The winter of 1903-4 was unusually severe, and the spring was late. At Ithaca the ground was frozen to a depth of five feet or more; this, with a deficiency in temperature from January 1st to April 30th, rendered spring work late. The temperature during May was above normal, but during every other month it was below normal, the annual deficiency being 29° F. A killing frost occurred as late as May 12 and corn was injured by a frost on September 22-23.

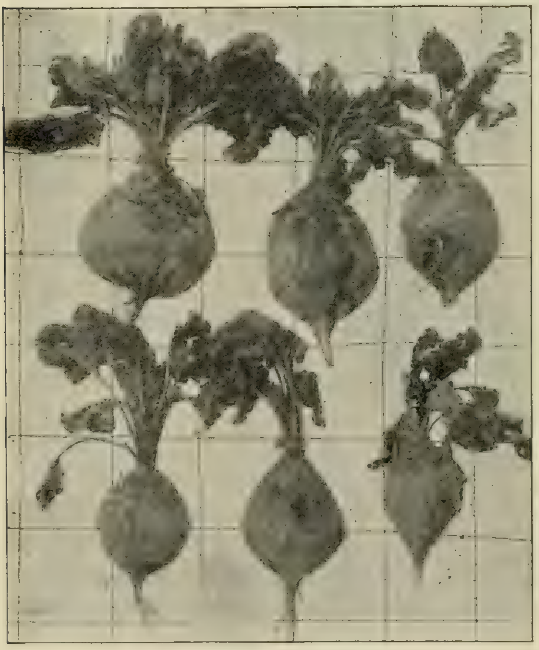

FIG. 21.—*Yellow Globe mangel. Typical of this shape. Like the preceding it yields low, but is well adapted to shallow soils. Upper row early sown; lower row late sown. Squares six inches.*

The land was manured at the rate of about 10 tons per acre, and plowed about eight inches deep as early as possible in the spring. The land was harrowed four times, as soon as plowed, with the spring-tooth harrow. As it had been well tilled

the year before, this put it in good condition. Four hundred pounds of acid phosphate (17 per cent. available) were sown broadcast and harrowed in. The land was rolled before sowing and the seeds put in with an Iron Age hand planter, the one with two wheels being preferred by all who used it.

The early sown part was seeded as time permitted between May 6 and 11, the mangels being sown during the afternoon of the 6th and the morning of the 7th at the rate of about eight pounds of seed per acre. The late-sown part was seeded on June 12.

The effort was made to sow mangel and parsnip seeds about three-fourths inches deep and all others one-half inch deep. The mangels came up in 12 days, the cabbages, rutabagas, hybrid turnips and common turnips in five to six days. The carrot seed was very slow in starting. It had not been soaked, as is sometimes advised. The parsnips were a failure. The rates of seeding per acre were: rutabagas about four pounds, hybrid and common turnips rather less, carrots six to seven pounds.

FIG. 22.—*Lane Improved sugar-beet. Upper row early sown; lower row late sown. A good yielder, vigorous grower, relatively high in dry matter, but not so easily harvested as mangels. Squares six inches.*

The culture was the same for all types. The hand cultivator was used twice in May, and the one-horse cultivator was used on May 20 and every two weeks during June and July, and in the case of the late sown crops until August or until the plants met in the row.

The common turnips and hybrid turnips having rough leaves were injured by soft rot, see p. 61. Aphis attacked the rutabagas and Pioneer hybrid turnips in September and it became necessary to spray the plants with whale-oil soap (one pound to six gallons of water) to check their ravages.

The common turnips were harvested July 18. All other roots were harvested October 22 and October 29. Samples

FIG. 23.—*The flesh of the mangel may vary in color, but always shows the fibrous ring. The largest rapid growing varieties tend to crack inside. This lessens value and keeping quality.*

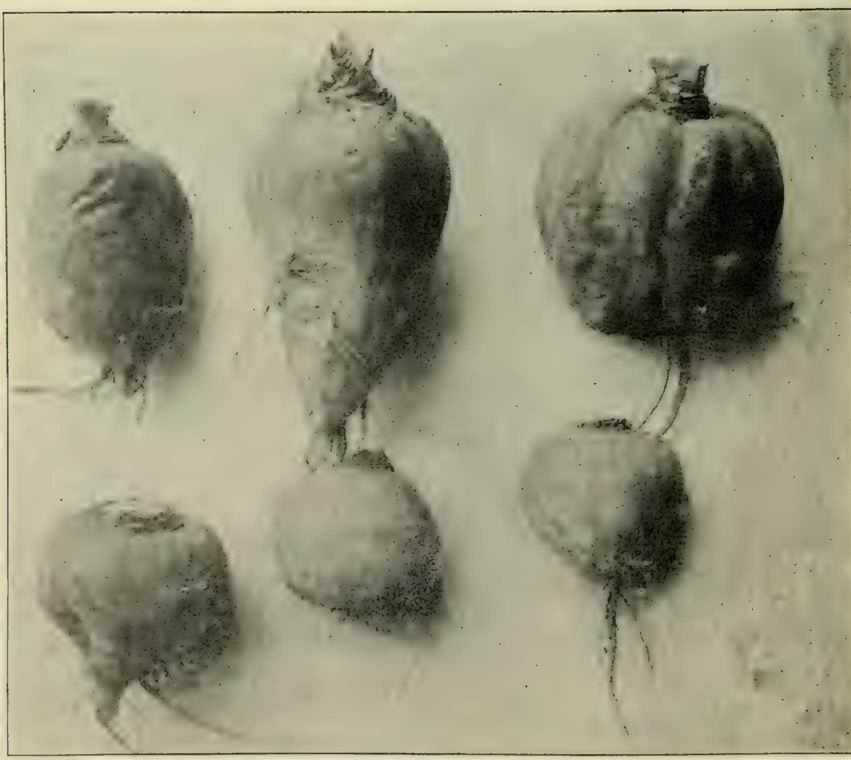

FIG. 24.—*Purple-top Mammoth turnip. Top row early sown; lower row late sown. Shape variable. A good yielder, but the larger roots are likely to become pithy.*

were taken as quickly as possible for dry matter determination by Dr. J. A. Bizzell, and all analyses, except those of sugar-beets in 1904, were made by him.

Sugar-beets.

Sugar-beets were not included in the list of types of roots just described, but they were grown at the same time in co-operation with the

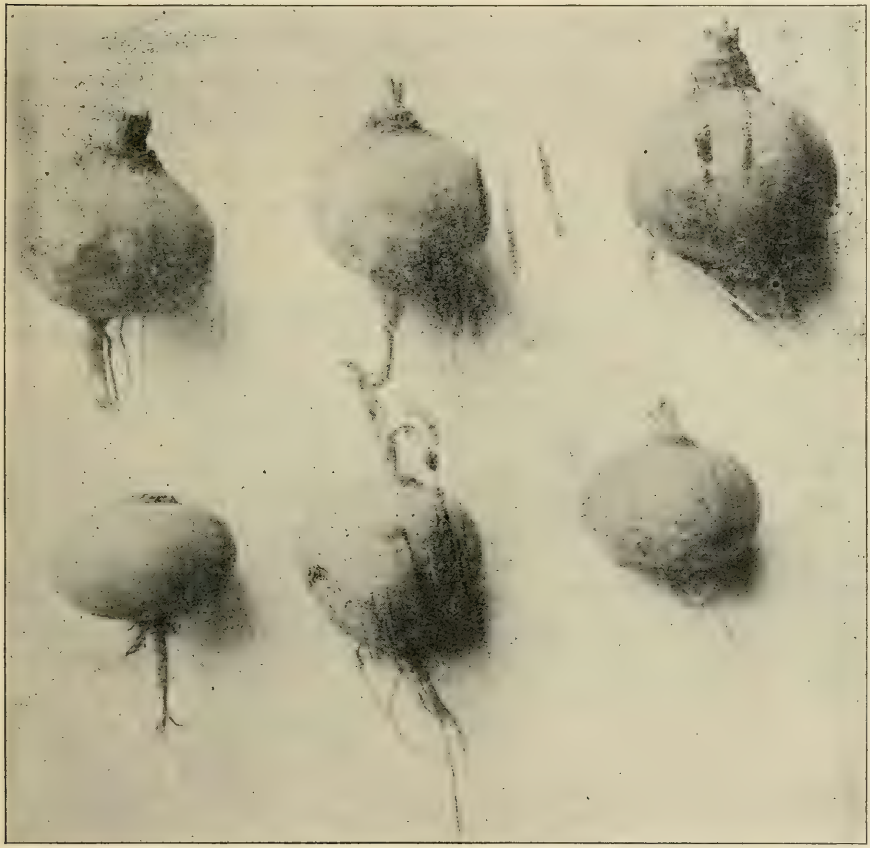

FIG. 25.—*Carter Green Globe turnip. A good yielder, large specimens sometimes weighing five pounds. In roundness, uniformity and appearance this variety is better than Fig. 24.*

United States Department of Agriculture on the Experiment Grounds some distance from the main experiment, on soil of the same general character. The early sown crop of sugar-beets was a failure. A second sowing was made June 16, 1904.

Part of the land had been growing sugar-beets for four consecutive years, this being the fifth successive crop. In 1903 the plants on this

area were affected by leaf spot (Cercospora beticola). This part is designated " no rotation plat." A piece of land adjoining had not grown sugar-beets previously but was sown this year and is designated " rotation plat."

The soil is a rich loam and had been well fitted. It was replowed and fertilized at the rate of 1,000 pounds per acre of a mixture containing four per cent. nitrogen, five per cent. phosphoric acid, and ten per cent. potash. The nitrogen was obtained from nitrate of soda and partly from high-grade dried blood, the phosphoric acid from acid phosphate 12 to 14 per cent. available and the potash from muriate of potash. In addition, air-slaked lime was applied at the rate of 1,500 pounds per acre. The fertilizers and lime were well harrowed in. The seed-bed was in excellent tilth.

The variety of sugar-beet was Kleinwanzlebener, seed grown by E. H. Morrison, Fairfield, Washington, and sent out by Department of Agriculture.

The seed was sown at a depth of one-half to three-fourths inches and at the rate of 12 pounds per acre. The plants were thinned to between six and eight inches asunder and the rows were 27 inches apart.

Harvesting of sugar-beets was begun September 13, 1904, and continued weekly until November 1, 1904. All analyses of sugar-beets in 1904 were made by the United States Department of Agriculture, Division of Chemistry. All calculations are based on 50 feet of row.

In the tables that follow the results are given in condensed form for both the early and the late sown crops. In spite of the fact that many of the plats of the early-sown mangels were on " no rotation " area and were badly attacked by leaf-spot and the yield correspondingly reduced, the results are strongly in favor of early sowing. The actual percentage gain in dry matter was 60 per cent.

Table I. General Crop of Roots, 1904.

Yields per acre, total and percentage dry matter, total and percentage sugar (dextrose), number of plants per acre and yield of tops, 1904:

	Yield per acre, tons.	Dry matter, per cent.	Dry matter per acre, tons.	Sugar per cent.	Sugaro per acre, tons.	Number f plants per acre, thousands.	Yield of tops per acre, tons.
Section 1. Mangels sown May 6-7.							
Average of seven plats.....	10.8	10.19	1.	4.72	.5	21	3.3
Average of three check plats	11.9	10.53	1.3	5.05	.6	23	4.6
Section 11. Mangels sown June 12.							
Average of seven plats.....	11.21	11.99	1.39	5.96	.69	28	4.
Average of three check plats	11.20	12.28	1.36	6.20	.69	28	4.8
Section 2. Rutabagas sown May 11.							
Average of seven plats.....	17.1	8.99	1.5	2.85	.5	28	
Average of three check plats	16.8	8.76	1.5	2.59	.4	27	
Section 12. Rutabagas sown June 12.							
Average of five plats.....	11.69	9.45	1.11	2.9	.34	24	
Average of one check plat..	9.26	10.11	.94	2.5	.23	18	
Section 3. Carrots sown May 6-7.							
Average of five plats.......	12.3	12.85	1.6	5.29	.7	25	3.1
Average of three check plats	13.1	12.77	1.7	5.05	.7	31	4.3
Section 13. Carrots sown June 12.							
Average of seven plats.....	9.80	12.66	1.25	5.6	.55	42	4.3
Average of three check plats	12.20	12.59	1.53	5.33	.65	47	4.1
Section 4. Mangels sown May 6-7.							
Average of seven plats.....	8.3	12.09	1.	6.02	.5	12	4.
Average of three check plats	12.0	12.4	1.5	6.2	.8	18	5.8
Section 14. Mangels sown June 12.							
Average of seven plats.....	7.34	13.26	.99	7.09	.52	18	3.3

TABLE I. GENERAL CROP OF ROOTS, 1904.—*Concluded.*

	Yield per acre, tons.	Dry matter per cent.	Dry matter per acre, tons.	Sugar per cent.	Sugar per acre, tons.	Number of plants per acre, thousands.	Yield of tops per acre, tons.
Section 14. Mangels sown June 12.—*Continued.*							
Average of three check plats	7.37	13.65	1.04	7.31	.54	21	3.3
Section 5. Parsnips sown May 11. Failure; resown June 12.							
....	8.	11.67	.9	5.87	5.5		
Section 7. Mangels sown May 6-7.							
Average of seven plats.....	33.5	11.92	4.0	6.47	2.2	25	5.8
Average of three check plats	32.3	11.07	3.6	6.03	2.0	25	7.2
Section 18. Mangels sown June 12.							
Average of seven plats.....	17.23	13.37	2.21	7.19	1.18	31	5.
Average of three check plats	13.78	15.01	2.04	8.13	1.10	31	5.6
Section 6a. Hybrid turnips sown May 11.							
Average of four plats......	21.4	8.19	1.8	2.20	.5	25	
Average of two check plats..	25.9	8.86	2.3	2.85	.7	26	
Section 17. Hybrid turnips sown June 12.							
Average of four plats......	11.9	8.8	1.05	2.49	.3	31	
Average of two check plats..	12.52	9.07	1.13	2.9	.36	31	
Section 8. Turnips sown May 11							
Average of three plats......	5.6						8.2
Average of two check plats..	4.7	9.09	.4	3.41	.1		8.8
Miscellaneous, sown July 20.							
Golden Ball turnip........	2.89	9.09	.26	3.41	.1	27	
Kangaroo rutabaga........	9.95	10.71	1.	4.82	.98	21	
Green top Scotch yellow turnip.................	3.48	9.91	.34	3.11	.11	41	
Cowhorn turnip...........	4.84	9.09	.44	3.45	.17	30	

THE EXPERIMENT OF 1905.

The soil in 1905 was Dunkirk clay loam in poor condition. For a description and analyses of this soil see Cornell University Bulletin 232, pp. 33, 34.

Rotation, 1902, Oats
1903, Oats
1904, Soybeans, fertilized
1905, Root-crops

FIG. 26.—*Effect of the soft rot (Bacillus carotovorus) is sometimes very destructive to turnips, and more so to some varieties than others. The Golden Ball is especially susceptible to the disease.*

The land was manured in the fall with cow manure at the rate of about 10 to 12 tons per acre. It was very slow in drying out and was not fit to plow until the beginning of May, at which time it was plowed eight inches deep, between the dates May 2 and 5. It was harrowed and limed at the rate of about 15 bushels (1200 pounds) unslaked freshly burnt lime per acre. The lime was slaked to a fine powder and then spread and harrowed in. After this, on May 6, the following fertilizers were applied per acre:

240 lbs. acid phosphate, 12 per cent. available, cost....	$1.10
120 lbs. dried blood, 16 per cent. available............	2.58
120 lbs. muriate of potash.........................	2.58
	$6.26

The dried blood was used because we happened to have it on hand; otherwise nitrate of soda might have been applied.

The land was harrowed and rolled and harrowed (the spring-tooth harrow being used on all occasions) on May 6. On the morning of May 8, it was harrowed well with the Meeker harrow which made an excellent seed-bed. All seeds were sown May 8 and 9, as just stated. The rows

FIG. 27.—*Commonwealth hybrid turnip. One of the best yielders. It matures early and is well adapted for fall use. Slightly attacked by soft-rot.*

were 30 inches apart and the seeds were sown with an Iron Age hand planter. No seeds were sown deeper than ¾ inch, the mangels being sown at about this depth.

The various turnips and cabbages were sown about ¼ to ½ inch deep, the parsnips about ½ inch deep and the carrots were sown as near the surface as could be done, many being almost uncovered. Trials in the green-house showed that carrots would not germinate in this soil when sown .75 inch deep but would grow well when sown ½ inch deep in sand; hence the reason for leaving them so near the surface of the

soil. The experiment comprised 28 sections and 190 plats. Half of these were sown early, May 8 and 9.

The common turnips, all of the hybrid turnips except Pioneer, and most of the cabbages were ready to harvest the first week of September and were harvested as soon as possible after this date. Since the fall was open, the remainder of the crops were left in the ground until

FIG. 28.—*Carter lightning hybrid turnip. A good yielder, but the flesh is not so solid as that of Commonwealth and it is perhaps more subject to soft-rot. Easily harvested.*

October, the carrots and parsnips not being harvested until the beginning of November.

Ten average specimens from each plat were used for analysis as in 1904, and all analyses were made by Dr. James A. Bizzell.

During 1905 there were 91 clear days, 126 partly cloudy, 148 cloudy days. It rained on 160 days. The total rainfall was 38.04 inches or 3.84 inches above the normal. The mean temperature was 46 or 1.1 degrees below normal. The temperature of the months of March and December and the important growing months for corn,—July, August, September

and October—was above the normal. All other months were below. The last killing frost of spring occurred on May 2, and the first of fall on October 26, thus affording a growing period of 175 days free from killing frost.

The following tables give the results in condensed form obtained during the second year of the trial. As in 1904, mangels were used as the check crop on every third section; and each section was checked in every third plat by a standard variety:

TABLE II. MANGELS.

AVERAGE OF YIELDS ON 24 PLATS SOWN MAY 6, 7, 1904.

Average yield per acre of total crop, dry matter and sugar (as dextrose) from seven varieties.

	No. of plats.	Average yield per acre, tons.	Per cent. of dry matter.	Dry matter per acre, tons.	Average per cent. of sugar.	Sugar per acre, tons.	Plants per acre, thousands.	Yield of tops per acre, tons.
Average of all Norbiton Giant.	10	21.2	11.24	2.4	5.67	1.2	22	6.4
Average of all Garton Long Red	3	18.5	11.48	2.2	5.68	1.1	14	3.2
Average of all Golden Tankard	3	12.6	12.76	1.7	6.59	.9	13	2.0
Average of all Yellow Globe	3	15.9	10.21	1.6	4.97	.8	19	1.9
Average of all Chirk Castle	3	19.9	11.35	2.4	5.59	1.3	24	5.6
Average of all Half-Sugar[1]	1	41.3	10.40	4.3	5.08	2.1	17	7.1
Average of all Sutton Long Red[1]	1	45.3	10.92	4.9	5.33	2.4	24	8.7
Average of all	**24**	**20.8**	**11.30**	**2.4**	**5.65**	**1.2**	**20**	**4.9**

[1] Not comparable except for ascertaining average.

AVERAGE OF 21 PLATS SOWN JUNE 12, 1904.

Average yield per acre of total crop, dry matter and sugar (as dextrose) from seven varieties.

Average of all Norbiton Giant.	8	9.2	12.97	1.2	6.75	.62	26	4.0
Average of all Garton Long Red[2]	4	15.9	11.55	1.9	5.99	.99	27	4.0
Average of all Golden Tankard[1]	2	9.7	11.63	1.1	5.70	.54	19	2.8
Average of all Chirk Castle[1]	1	12.0	12.04	1.4	6.07	.73	29	3.9
Average of all Sutton Long Red[1]	1	5.7	14.02	.8	7.88	.45	9	2.3
Average of all Mammoth Long (Purple Top)[3]	4	13.8	15.01	2.0	8.13	1.10	31	5.6
Average of all Half-Sugar[3]	1	20.9	11.01	2.3	5.77	1.21	31	4.1
Average of all	**21**	**11.93**	**12.87**	**1.5**	**6.75**	**.75**	**26**	**4.1**

[1] Grown on "no rotation" area.
[2] Two plat on "rotation" area and two on "no rotation" areas.
[3] Grown on "rotation area," not comparable except for ascertaining average.

TABLE III. GENERAL CROP FOR 1905.

Yield per acre, total and per cent. of dry matter, number of plants and yield of tops.

	Yield per acre, tons.	Per cent. dry matter.	Dry matter per acre, tons.	Plants per acre, thousands.	Yield of tops per acre, tons.
Section 1. Mangels sown May 8.					
Average of ten plats	29.7	10.38	3.07	28	4.3
Average of four check plats	30.6	10.69	3.26	29	5.1
Section 21. Mangels sown June 14.					
Average of seven plats	23.6	10.15	2.41	29	5.5
Average of three check plats	22.9	11.18	2.57	28	6.0
Section 2. Half-sugar mangels sown May 8.					
Average of seven plats	29.5	11.14	3.29	28	3.7
Average of three check plats	28.0	12.38	3.44	28	5.3
Section 22. Half-sugar mangels sown June 14.					
Average of seven plats	22.8	10.83	2.50	28	5.4
Average of three check plats	23.5	10.82	2.58	28	7.3
Section 3. Sugar beets sown May 8.					
Average of seven plats	26.9	15.83	4.06	29	5.8
Average of three check plats	20.3	19.84	4.07	29	8.c
Section 23. Sugar-beets sown June 14.					
Average of seven plats	19.2	14.47	2.92	25	8.8
Average of three check plats	15.0	19.13	2.87	21	10.5
Section 4. Mangels sown May 8.					
Average of seven plats	28.7	11.71	3.36	27	4.9
Average of three check plats	30.1	12.35	3.71	28	5.9
Section 24. Mangels sown June 14.					
Average of seven plats	21.8	12.55	2.71	29	.70
Average of three check plats	21.6	12.43	2.87	28	7.0
Section 5. Carrots sown May 9.					
Average of seven plats	16.8	11.23	1.86	39	2.7
Average of three check plats	15.9	11.96	1.89	39	2.4

TABLE III. GENERAL CROP FOR 1905.—Continued.

	Yield per acre, tons.	Per cent. dry matter.	Dry matter per acre, tons.	Plants per acre, thousands.	Yield of tops per acre, tons.
Section 25. Carrots sown June 14.					
Average of six plats	8.6	10.28	1.03	37	2.8
Average of two check plats	9.2	12.18	1.12	36	3.0
Section 6. Hybrid turnips sown May 9.					
Average of seven plats	24.7	8.6	2.17	23	6.0
Average of three check plats	29.3	9.03	2.65	22	6.4
Section 26. Hybrid turnips sown June 14.					
Average of seven plats	14.8	8.19	1.22	27	7.5
Average of three check plats	16.6	9.58	1.59	26	6.4
Section 7. Mangels sown May 8.					
Average of seven plats	23.6	12.60	2.96	26	5.4
Average of three check plats	21.3	13.14	2.78	26	5.8
Section 27. Mangels sown June 14.					
Average of seven plats	16.5	12.58	2.04	28	7.3
Average of three check plats	11.0	13.34	1.47	26	8.2
Section 9. Rutabagas sown May 9.					
Average of seven plats	25.8	9.3	2.4	22	4.3
Average of three check plats	26.5	9.54	2.53	22	3.7
Section 29. Rutabagas sown June 14.					
Average of seven plats	12.3	9.18	1.12	23	3.5
Average of three check plats	12.3	9.31	1.14	23	2.6
Section 10. Mangels sown May 8.					
Average of seven plats	22.9	12.76	2.92	26	5.5
Average of three check plats	23.6	13.54	3.21	27	6.4
Section 30. Mangels sown June 14.					
Average of seven plats	14.1	12.56	1.74	24	7.3
Average of three check plats	8.9	13.6	1.16	21	7.0

TABLE III. GENERAL CROP FOR 1905.—Concluded.

	Yield per acre, tons.	Per cent. dry matter.	Dry matter per acre, tons.	Plants per acre, thousands.	Yield of tops per acre, tons.
Section 11. Turnips sown May 9.					
Average of six plats	23.2	10.01	2.41	24	5.2
Average of three check plats	25.6	12.20	3.12	26	4.4
Section 31. Turnips sown June 14.					
Average of seven plats	13.6	9.24	1.34	26	5.3
Average of three check plats	17.7	12.00	2.13	30	3.5
Section 12. Kohlrabi and parsnips sown May 9.					
Average four plats kohlrabi	22.3	10.05	2.23	23	
Average of three plats parsnips	8.0	20.3	1.62	34	1.7
Section 32. Kohlrabi and parsnips sown June 14.					
Average four plats kohlrabi	20.0	9.47	1.88	31	
Average one plat parsnip	2.0	19.16	.38	27	1.6
Section 13. Mangels sown May 9.					
Average of seven plats	22.6	11.53	2.53	28	4.9
Average of three check plats	22.9	12.63	2.67	30	6.3
Section 33. Mangels sown June 14.					
Average of seven plats	15.1	11.71	1.70	23	7.3
Average of three check plats	9.1	12.67	1.13	20	7.6

TABLE IV. EARLY AND LATE SOWING OF MANGELS IN 1905.

The following tables show the yields from seven varieties of mangels sown May 8, and 9, and June 14, 1905.

SUMMARY OF THE YIELDS OF MANGELS SOWN MAY 8 AND 9, 1905.

VARIETY.	Number of plats.	Average yield per acre, tons.	Per cent. of dry matter.	Average yield of dry matter per acre, tons.	Average number of roots per acre, thousands.	Yield of tops per acre, tons.
Chirk Castle	5	26.9	12.56	3.36	27	1.9
Norbiton Giant	16	25.7	12.32	3.08	28	2.0
Sutton Long Red	5	28.5	10.48	2.95	26	2.2
Garton Long Red	4	23.0	11.91	2.70	26	1.7
Carter Golden Tankard	5	24.7	10.69	2.65	27	2.0
Carter Windsor Yellow Globe	1	40.7	7.52	3.06	28	3.0
Carter Red Emperor	1	24.7	9.06	2.36	29	3.0
Average	**37**	**26.2**	**11.62**	**3.00**	**28**	**2.**

SUMMARY OF THE YIELD OF MANGELS SOWN JUNE 14, 1905.

VARIETY.	Number of plats.	Average yield per acre, tons.	Per cent. of dry matter.	Average yield of dry matter per acre, tons.	Average number of roots per acre, thousands.	Yield of tops per acre, tons.
Norbiton Giant	10	22.1	11.80	2.60	28	1.5
Sutton Long Red	5	23.1	11.21	2.56	28	1.6
Garton Long Red	5	20.7	11.3	2.33	29	1.4
Chirk Castle	5	19.6	11.69	2.27	28	1.4
Carter Golden Tankard	5	19.5	11.12	2.15	27	1.4
Carter Windsor Yellow Globe	1	27.0	7.78	2.10	30	1.7
Carter Red Emperor	1	15.5	8.83	1.41	30	1.0
Average	**32**	**21.2**	**11.29**	**2.38**	**28**	**1.5**

From the above tables it will be seen that during 1905, as in 1904, (see p. 99) sowing mangels early in May was much more profitable than sowing the middle of June.

The actual average yields of dry matter per acre were:

	1904, tons.	1905, tons.
May sowing	2.4	3.
June sowing	1.5	2.38
Gain in favor of May sowing	9	.62
Gain per cent	60.	26.

TABLE V. NORBITON GIANT MANGEL.

In the case of the variety Norbiton Giant, nine plats were sown on June 26, and these were compared with the nine plats near them, sown on May 8. The results are shown in the following table:

	Yield per acre, tons.	Percentage of dry matter.	Yield of dry matter per acre, tons.	Number of plants harvested per acre, thousands.
Sown May 8	22.6	13.10	2.88	28
Sown June 26	9.6	13.02	1.25	23
Gain from early sowing	13.0	0.08	1.63	5.0

NOTE.—Although the number of plants per acre appears to be larger on the early-sown plats, this is more apparent than real. None except roots of sufficient size were harvested and counted, so that many small plants on the late-sown plats were left.

THE EXPERIMENT OF 1906.

The area devoted to the experiment consisted of 1.5 acres. The land was in corn in 1905 and in timothy for several years previous. The soil is Dunkirk clay loam.

FIG. 29.—*Green-top Scotch yellow hybrid turnip. A good variety for late harvesting. Its vigorous foliage protects it.*

The land was plowed in the fall, after which it was limed and manure applied at the rate of 10 tons per acre. In the spring it was disked as soon as it was dry enough to work (May 8). On May 11 the following fertilizers were applied: dried blood, 120 pounds per acre; acid phosphate, 240 pounds per acre; muriate of potash, 120 pounds per acre. The fertilizers were sown broadcast and harrowed in with a spring-tooth harrow The day before the seed was sown the land was thoroughly fitted with a Meeker harrow.

The seeds were sown May 16, with the exception of the carrots, which were sown the day previous. An Iron Age hand planter was used

for this purpose. The rows were 30 inches apart. No late sowing was made, as the results of the two previous years showed that early sowing was the better.

The seeds of the beet type were sown at a depth of one-half inch, the turnips and cabbages about one-fourth inch, while the carrots and parsnips were sown as near the surface as possible. As soon as the plants began to come through, a hand cultivator was run close to the rows in order to break up the crust that had formed on the soil, which if left undisturbed would have prevented many plants from coming up, thus reducing the stand. After a second cultivation by hand, a one-horse cultivator was used at intervals of about 10 days until the plants nearly met in the row, thus preventing further cultivation.

Fig. 30.—*Garton Pioneer hybrid turnip. A very good yielder. It produces too much neck however. It keeps well and is not readily attacked by soft-rot.*

The turnips and hybrid turnips, with the exception of Garton Pioneer, were harvested in August, the remainder during the month of October. The yields of those which were harvested early were greatly reduced by soft-rot (Bacillus carotovorous).

Samples consisting of 10 average specimens (5 in the case of cabbages) were taken at the time of harvest and the dry matter determined by Dr. James A. Bizzell.

The following table gives the normal and monthly temperatures and rainfall at Ithaca, N. Y., during the period from May to October, 1906, inclusive:

	Temperature.		Rainfall.	
	Normal.	1906.	Normal.	1906.
May	57.3	56.1	3.72	3.71
June	66.3	67.0	3.71	7.06
July	70.2	69.4	3.81	1.94
August	67.8	71.0	3.37	2.53
September	61.5	64.4	2.78	1.83
October	50.0	50.0	3.16	3.30

Attention should be called to the fact that the temperature through the growing months of July, August and September was considerably above the normal, and that the rainfall during these months was considerably below normal. This combination of climatic factors affected the growth of the crops and the yield was somewhat reduced.

TABLE VI. GENERAL CROP OF 1906.

Table showing yields per acre of fresh substance, dry matter, tops, number of plants and per cent. of dry matter.

	Yield per acre, tons.	Per cent. of dry matter.	Yield of dry matter per acre, tons.	Number plants per acre, thousands.	Yield of tops per acre, tons.
Section 1. Mangels.					
Average of thirteen plats......	23.8	10.38	2.48	17	2.3
Average of five check plats....	25.4	11.57	2.94	18	3.1
Section 2. Half-sugar mangels with mangels as check.					
Average of four plats.........	23.6	11.03	2.59	16	1.8
Average of three check plats...	23.0	10.98	2.52	15	2.7
Section 3. Sugar-beets.					
Average of seven plats.........	20.7	15.15	3.03	18	3.8
Average of three check plats...	17.6	19.57	3.45	19	5.2
Section 4. Mangels.					
Average of seven plats........	22.5	10.65	2.40	17	2.4
Average of three check plats...	22.3	11.93	2.65	17	2.8
Section 5. Carrots.					
Average of ten plats..........	11.3	11.15	1.25	26	2.4
Average of four check plats....	10.0	11.86	1.19	26	2.0
Section 6, Hybrid Turnips.					
Average of seven plats........	18.1	9.23	1.70	18	7.3
Average of three check plats...	22.6	10.50	2.37	22	5.9
Section 7. Mangels.					
Average of seven plats........	19.9	10.39	2.08	16	1.9
Average of three check plats...	19.9	11.49	2.28	17	2.0

TABLE VI. GENERAL CROP OF 1906.—Concluded.

	Yield per acre, tons.	Per cent. of dry matter.	Yield of dry matter per acre, tons.	Number of plants per acre, thousands.	Yield of tops per acre, tons.
Section 8. Mangels.					
Average of seven plats........	31.0	10.82	3.35	19	3.9
Average of three check plats...	31.4	11.45	3.58	19	3.9
Section 10. Rutabagas.					
Average of ten plats..........	26.0	9.85	2.55	18	3.9
Average of four check plats....	25.0	10.02	2.51	18	4.0
Section 11. Mangels.					
Average of seven plats........	21.9	9.85	2.17	18	2.6
Average of three check plats...	21.6	10.52	2.28	18	2.9
Section 12. Turnips.					
Average of eight plats.........	12.1	8.19	.99	14	5.8
Average of five check plats....	21.9	13.60	2.98	22	5.2
Section 13. Kohlrabi.					
Average of four plats.........	20.0	9.16	1.83	16	3.9
Average of two check plats....	21.4	9.27	1.97	17	3.2
Section 14. Parsnips.					
Average of three plats.........	8.1	18.69	1.51	35	2.3
Section 15. Mangels.					
Average of seven plats........	24.8	9.28	2.32	18	2.5
Average of four check plats....	26.0	9.97	2.59	18	2.8

Table VII. Summary of Yields of Mangels, 1906.

	Number of plats.	Average yield per acre, tons.	Average per cent. dry matter.	Average yield dry matter per acre, tons.	Number of plants per acre, thousands.	Yield of tops per acre, tons.
Norbiton Giant	23	24.3	11.17	2.71	17	2.9
Sutton Long Red	6	25.5	9.87	2.50	16	2.4
Gate Post	6	21.1	8.83	1.94	18	1.4
Chirk Castle	6	24.7	9.79	2.42	19	2.9
Garton Long Red	6	24.2	9.94	2.40	18	2.8
Carter Red Emperor	1	23.7	10.43	2.47	17	1.7
Windsor Yellow Globe	1	25.9	7.56	1.90	18	1.2
Carter Golden Tankard	1	20.2	9.29	1.88	15	1.7
Red Giant Ovoid	1	17.8	10.07	1.79	14	1.6
Average of all varieties	**51**	**23.9**	**10.29**	**2.47**	**17**	**2.6**

SUMMARY FOR THREE YEARS.

A summary of the results for the three years appears in the following table (VIII). It is difficult to make a comparative study of these results on any other than a dry-matter basis. From this point of view it will be noticed that sugar-beets give the highest average of dry matter, but the difficulty of harvesting these perhaps offsets their advantage in yield. They are more difficult to harvest and more of them must be handled. Next in yield of dry matter stands the mangels and half-sugar mangels, with rutabagas and cabbages following next closely. No doubt, in general the greatest economy will be practiced by growing cabbages, rutabagas and mangels for succession-harvesting and feeding, more especially on farms where sheep and swine are kept.

TABLE VIII. MAXMIUM, MINIMUM AND AVERAGE YIELDS OF FRESH AND DRY SUBSTANCE PER ACRE FOR THREE YEARS.

MAXIMUM.

	1904.		1905.		1906.		AVERAGE.	
	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.
Mangels	45.3	10,258	40.0	7,100	33.8	8,000	39.7	8,453
Half-sugar			30.8	7,420	25.3	5,460	28.1	6,440
Sugar beets			33.3	8,980	23.2	7,200	28.3	8,090
Carrots	15.7	4,617	25.7	5,320	14.2	3,200	18.5	4,379
Rutabagas	21.8	4,177	27.2	5,200	30.0	5,860	26.3	5,079
Hybrid turnips	27.0	4,714	31.2	5,700	23.0	4,920	27.1	5,111
Turnips	7.6		25.8	3,980	17.2	3,020	16.8	3,500
Kohlrabi			23.7	5,020	23.1	4,060	23.4	4,540
Cabbages	51.2	7,783	32.0	4,040	26.1	4,940	36.4	5,588
Parsnips					8.3	3,680	8.3	3,680
MINIMUM.								
Mangels	3.6	824	16.0	3,040	16.1	2,640	11.9	2,168
Half-sugar			28.4	5,960	22.0	5,000	25.2	5,480
Sugar-beets			18.0	6,840	17.1	5,180	17.6	6,014
Carrots	1.1	2,175	7.2	1,760	7.0	1,700	5.1	1,878
Rutabagas	12.3	2,251	23.7	4,120	22.4	4,240	19.5	3,537
Hybrid turnips	16.0	2,512	19.7	3,260	11.0	1,980	15.6	2,584
Turnips	4.4		14.5	2,300	6.8	1,120	8.6	1,710
Kohlrabi			21.5	3,920	18.1	3,220	19.8	3,570
Cabbages	34.5	5,348	26.9	3,160	19.8	3,720	27.1	4,076
Parsnips					7.9	2,080	7.9	2,080
AVERAGE.								
Mangels	20.8	4,726	26.2	5,800	23.9	4,940	23.6	5,155
Half-sugar			29.6	6,580	23.6	5,180	26.6	5,880
Sugar-beets			26.9	8,120	20.7	6,060	23.8	7,090

TABLE VIII. SUMMARY.—Concluded.
AVERAGE—Concluded.

	1904.		1905.		1906.		AVERAGE.	
	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.	Fresh substance, tons.	Dry substance, lbs.
Carrots	9.6	3,181	16.8	3,720	11.3	2,500	12.6	3,134
Rutabagas	17.1	3,074	25.8	4,820	26.0	5,100	23.0	4,331
Hybrid turnips	21.4	3,561	24.7	4,120	18.1	3,400	21.4	3,694
Turnips	5.6		20.9	3,380	12.1	1,980	12.9	2,680
Kohlrabi			22.3	4,480	20.0	3,660	21.2	4,070
Cabbages	43.8	6,206	29.0	3,640	22.5	4,140	31.8	4,662
Parsnips			8.0	3,240	8.1	3,020	8.1	3,130

Lessons from the tables:

The teaching of these figures is that a profitable yield of stock feed may be harvested under average seasonal conditions from practically all these types of roots. As was pointed out on page 89, a greater average yield of dry matter per acre may be obtained from mangels, half-sugar mangels, sugar-beets and rutabagas than from an average yield of corn. While it costs somewhat more per pound to produce this dry matter, yet it is quite probable that the higher digestibility and palatability of roots offset this lesser cost of corn.

The tables show further that, comparing mangels and sugar-beets, the former are more succulent, while the sugar-beets produce a higher average yield of dry matter. It should be remembered, however, as pointed out on p. 111, that because the sugar-beets grow into the ground, they are more difficult to harvest; and furthermore, they do not keep so well as mangels. It may seem that the yield of sugar-beets is more uniform than that of mangels, but this is due to the fact that the yield of different varieties of mangels varies more widely than that of the varieties of sugar-beets.

The rutabagas produce profitable yields of food material, and the fact that they are well adapted to early feeding and also to the feeding of swine, as well as to sheep and cattle, adds to their value.

Turnips, as a general rule, do not yield as well as the above mentioned roots, and, furthermore, they are more liable to attacks of disease.

8

However, they are useful for early feeding, and are especially valuable for sheep.

Carrots and parsnips, while yielding a fair percentage of dry matter, do not yield a sufficient quantity of food material to warrant general planting for stock-feeding. However, they are exceptionally good as a condimental food, and for horses.

The results of 1904 and 1905 show plainly that early planting of all roots for stock-feeding is desirable. Rutabagas, however, may be planted a little later than the others. It has not been shown that the more fibrous and heavier rutabagas of a longer-growing season are less digestible or palatable than the more succulent roots of the shorter-growing season.

FIG. 31.—*Garton's Monarch rutabaga. Upper row early sown; lower row late sown. The roots are generally uniform in size and shape and are solid. They are somewhat affected by clubroot disease.*

HARVESTING AND STORING ROOTS.

Roots are generally harvested by hand, except in the case of the sugar-beets, when a plow may be used to raise them from the ground. When turnips, rutabagas and mangels are grown for succession-feeding, the turnips are generally harvested first, before frost. Slight frosts in the late fall will not injure rutabagas or mangels, although the first frost should be a sign of harvesting time unless it be exceptionally early and very sure to be followed by later warm weather. In late summer and early fall, the tops do not grow much, yet the roots are developing and ripening rapidly.

In the case of mangels, rutabagas and most turnips the plants can be pulled by hand, the tops twisted off as they are pulled and the roots piled

or thrown directly into the wagon. It is thought that piling and afterwards loading is less fatiguing than throwing the roots directly into the wagon as pulled. The roots should reach their place of storage with as little dirt and bruising as possible.

Roots may be stored in a cellar, or in a pit in the field. The cellar is the better, whenever practicable. It may be a part of the barn structure, or built under the driveway of a bank barn, or it may be built as a dugout in a side hill near the barn. Perhaps concrete is the best material for construction. It should be not over seven or eight feet deep and large enough to hold the yield or supply. It is best to have it located and constructed in such a way that the roots can be dropped in from above, preferably through trap doors in the bottom of the wagon and the roof of the cellar. It is essential that the walls (if built in the ground) and the floor have good drainage and that ventilation be provided through the top, and that the construction be frost proof. The ventilators should be left open until sweating has ceased, when they may be closed for the winter. In winter the cellar should be kept closed as much as possible on warm days. Roots should be so placed that turnips may be fed first, rutabagas next and after these mangels and carrots.

If stored in a pit in the field, a high dry place should be chosen. If the ground is clayey the roots should be placed on top of the ground; if it is gravelly and drainage is good, a shallow pit about five feet wide and of necessary length may be shoveled out. The roots should be carefully placed in a gable-shaped pile about five feet wide and as long as convenient. A thin layer of straw should then be laid over the pile and this covered with six to eight inches of earth. Another and thicker layer of straw and a final layer of earth will complete the work. Ventilators should be placed at intervals of ten or fifteen feet, which should be closed when sweating has ceased. The pit should not be opened on warm days in winter. A ditch for drainage should be cut around the pit. Roots stored in this way do not keep as well as when stored in a good cellar; therefore, they should be fed out as early as possible.

FEEDING.

Roots of some kind are good for all domestic animals. Their effect is tonic as well as nutritive. Breeders and feeders of animals for exhibition find them invaluable. For most purposes the roots are chopped or sliced before feeding. Various hand and power machines are on the market for this work. Generally speaking, roots should not be fed alone as they carry too much water. A feed may vary from 25 to 50 pounds per day for a thousand pounds of animal, according to the amount of dry concentrates and roughage fed. It is usual to put the cut roots into

the feed box and distribute the ground grain over them. For poultry, however, the whole roots may be given, allowing the fowls to pick them. It is said by some that turnips and rutabagas impart a flavor to milk. However, if no roots are in the milking room at the time of milking and they are fed just after milking, this may be avoided.

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CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Agronomy

CULTURE AND VARIETIES OF ROOTS FOR STOCK-FEEDING

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CULTURE AND VARIETIES OF ROOTS FOR STOCK-FEEDING.

In Bulletin 243 the merits of roots for stock-feeding were discussed. It now remains to explain the culture of these roots, as experience at the Cornell Station has determined it, and to describe the leading varieties.

I—GENERAL ADVICE ON THE CULTIVATION OF ROOTS (pp. 119-129).

Seeds and seeding:

What is usually spoken of as " seed " in the case of mangels, half-sugar mangels and sugar-beets is really a fruit or capsule. This capsule may contain from one to seven seeds, three to five being common in large-sized capsules. Since the percentage germination power is expressed in the number of fruits, it frequently goes above 100 per cent. When 150 per cent. germination power is reached it frequently means that the germination power of the true seeds is actually but 50 per cent., for there would probably be on an average three seeds in a fruit and out of 100 capsules containing 300 seeds but 150 seeds germinated.

Almost all of the samples received at Cornell contained considerable dust; in some samples the dust and pieces of stem reached as high as 7 per cent. of the total weight.

The commercial seeds of rutabagas, hybrid turnips, common turnips, cabbages and kohlrabi are true seeds. The charts (Figs. 35–37) showing these five types are on the same scale and it will be readily seen that the data agree with the common impressions, viz., that

1. The seeds of common turnips are, as a class, the smallest.
2. The seeds of hybrid turnips are smaller than those of rutabagas.
3. The rutabagas are the largest of the turnip group.
4. Kohlrabi seeds are, as a class, smaller than those of cabbage.
5. Cabbage seed is the largest, but it is variable in size.

The significance of these data is that when sowing smaller seeds of equal germination power a fewer number of pounds of seed are required per acre.

The commercial seed of carrots is in reality a fruit, each fruit bearing one seed. Carrot seed as purchased frequently contains 5 to 10 per cent. by weight of adulterants, and in two of the samples sown the main adulterant was small quartz pebbles, turnip seeds, buckwheat, stalks and dust making up the remainder. The quartz pebbles were similar to those manufactured in Europe for the special purpose of adulterating seeds. All of the samples examined were remarkably uniform in the number of seeds in a pound but varied widely in germination power, the extremes

being 15 per cent. and 83 per cent. In 1904, Wiltshire and Belgian, two useful varieties for stock-feeding, were sown, but were absolute failures owing to poor seed. Not one per cent. of the seed would grow although sown under particularly favorable conditions. Carrot seed costs 60 cents to $1 per lb., and, taking the lower figure, it is evident that in the case

FIG. 32.—*Soil in fine tilth and a mellow seed-bed are prime requisites for successful root crop culture.*

of Carter 100-Ton carrot which tests 15 per cent. germination power, the actual cost of one pound of seed, which would grow, was, not 60 cents but $4.00.

The number of "seeds" in a pound of mangel seed we found to vary from 32,000 to 185,000 and the germination power from 73 to 185 per cent. This is of considerable importance in seeding, since it will require 16 pounds of seed per acre in one case to give as many plants as would be secured from six pounds per acre of another.

Half-sugar mangels varied from 24,000 to 36,000 fruits to the pound and the germination power from 100 to 136 per cent.

Sugar-beets varied from 22,000 to 24,000 fruits to the pound and the germination power from 102 to 132 per cent.

Rutabaga seeds varied from 161,000 to 188,000 seeds to the pound and the germination power varied from 83 to 92 per cent.

FIG. 33.—*Root crop seedlings are small and weak and cannot battle against adverse conditions.*

Hybrid turnip seeds varied from 183,000 to 266,000 seeds to the pound and the germination power varied from 71 to 94 per cent.

Common turnip seed varied from 200,000 to 260,000 seeds to the pound and the germination power from 89 to 92 per cent.

Kohlrabi seed varied from 114,000 to 129,000 seeds to the pound and the germination power ranged from 48 to 96 per cent.

Carrot seed varied from 440,000 to 460,000 seeds to the pound and the germination power ranged from 15 to 83 per cent.

Importance of testing germination power:

In the case of kohlrabi, one sample of seed tested as low as 48 per cent. It was returned to the seedsman. In the case of carrots, one sample tested as low as 15 per cent. Since the seed was imported and the variety considered desirable, it was sown. On account of the low viability the seeding was heavy and a good stand and profitable crop were then secured. (See p. 130.) Over 80 seeds were sown, however, for every

FIG. 34.—*The Meeker disc harrow is one of the best implements for making a fine seed-bed. It fines the soil but does not compact it. It facilitates uniform seeding.*

carrot grown, which gives a good idea of the vast waste attending the purchase of seeds low in germination power. The lesson is, to buy all seeds early in the season and test them for purity and viability. If this had not been done the seeds would have been sown too thin.

Time to sow:

In the first two years, sowing from May 6-9 was better than June 12 with all roots. Late sowing was not repeated in 1906. In general, early planting promotes keeping quality, as well as yield and dry-matter content. The seeds should be planted about early corn-planting time,

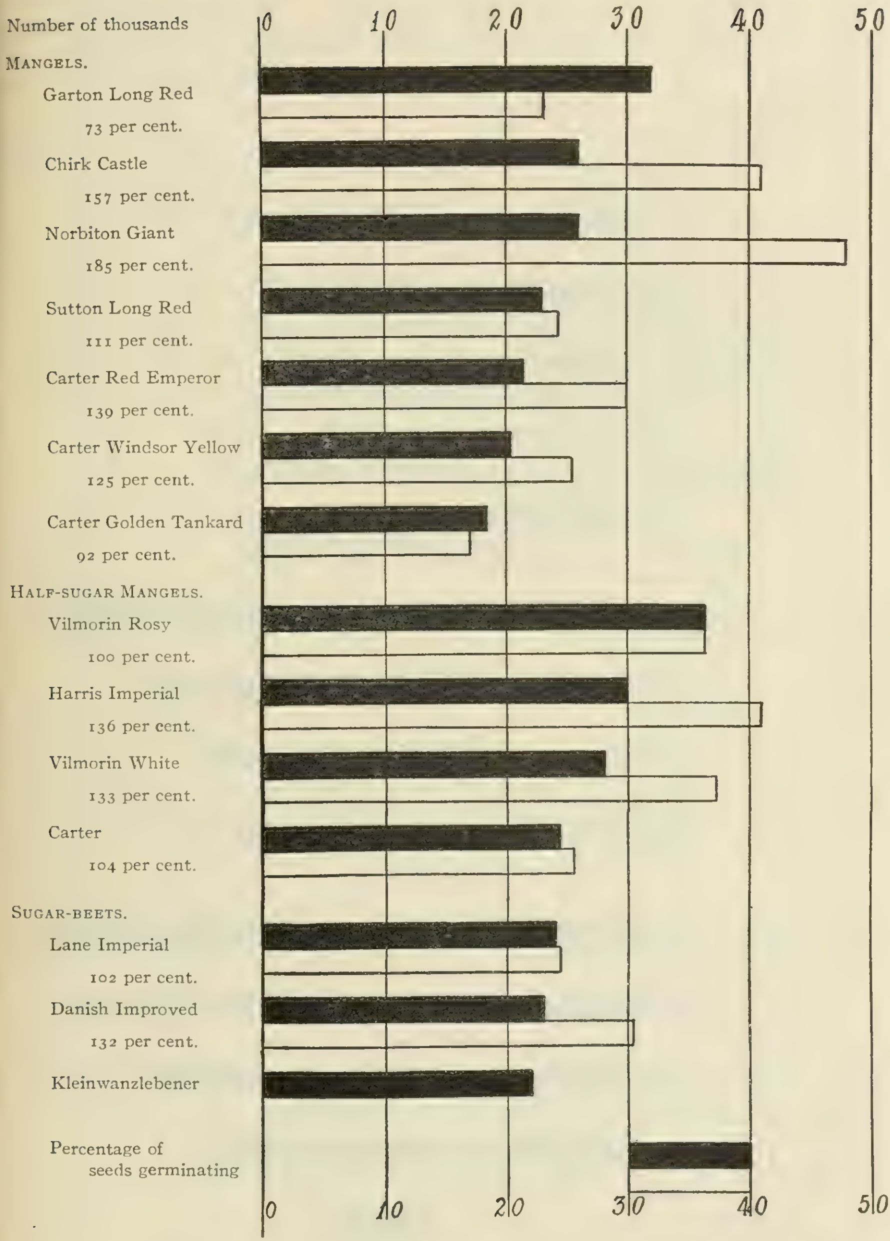

FIG. 35.—*Chart showing relation of seed-balls to percentages of germination for mangels, half-sugar and sugar-beets. The heavy bar represents the thousands of seed-balls per pound; the light bar the thousands of seeds in a pound germinating.*

that is, early in May. At this time the moisture conditions are more satisfactory, and for high yield and dry matter content, a long growing season is necessary. A long season also insures maturity and hence keeping quality.

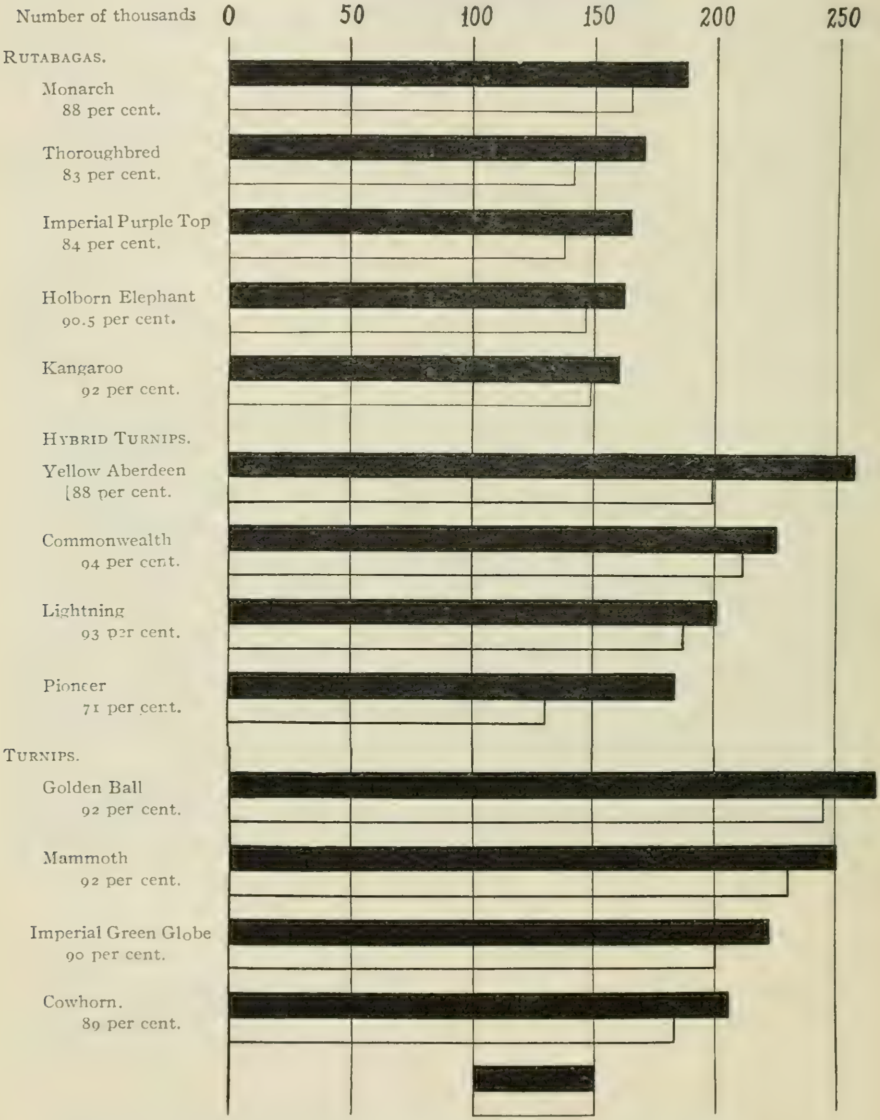

FIG. 36.—*Chart showing relative number of seeds per pound to the number germinating. The heavy bar represents the number of thousands per pound; the light bar the thousands germinating.*

Depth of sowing:

On the Dunkirk clay loam, carrot seed would not grow when sown one-fourth inch deep, but it grew well when sown five-eighths inch deep in sand. On the clay loam it was necessary to sow it practically on the surface. Seeds of all other crops were sown shallow, mangels, sugar-beets and half-sugar mangels not over three-fourths inch deep, and all others between one-fourth and one-half inch deep.

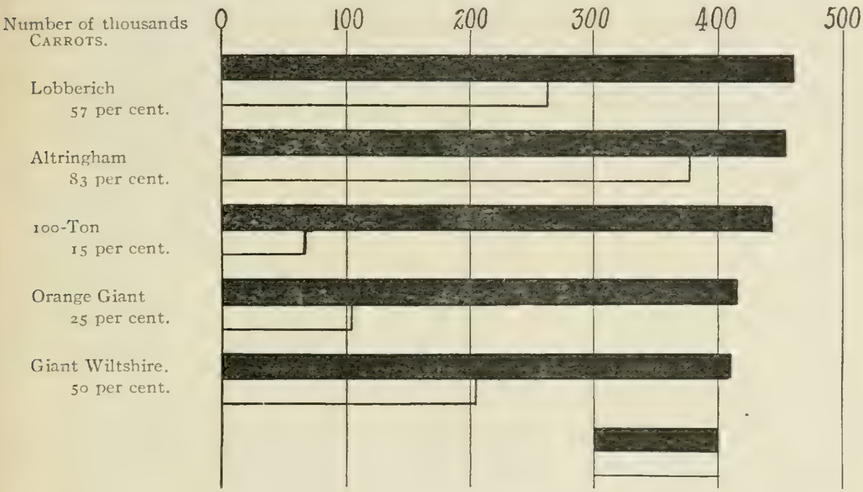

FIG. 37.—*Chart showing relation of number of seeds per pound to the number germinating for carrots. The heavy bar represents the number of thousands per pound; the light bar the thousands germinating.*

Distance between rows of roots:

Twenty-seven inch rows were used in 1904, and 30 inch in 1905 and 1906. The latter is advised because horse culture can be maintained for a longer period of time. The aim is not, necessarily, to produce the greatest yield per acre, but the highest yield per row, and thus produce roots at the lowest cost per ton. This can probably be better accomplished by wide rows, full of plants and fewer rows to the acre, and the use of horse tillage implements, than by narrower rows, a greater number to the acre and more hand labor.

Thinning:

It is essential that the plants be thinned before they become " drawn " or " leggy." Mangels were ready to thin about 30 to 35 days after sowing, rutabagas 25 to 30 days, hybrid and common turnips 16 to 25 days, carrots and parsnips about 35 to 40 days.

Cultivation:

Clean culture was maintained. If flea-beetles appeared or the roots did not appear to be growing as fast as they ought, an application of 100 pounds per acre of nitrate of soda was made. This practice is advised.

FIG. 38.—*Chirk Castle, a medium long mangel, one of the best yielders and high in dry matter. Some specimens, however, bear forked roots.*

Time of harvesting:

Common turnips, some of the hybrid turnips and cabbages were ready for harvest and use the beginning of September, and were used until November. All other roots were harvested and stored in October and early in November.

Uses:

A succession of root-crops is suggested for cattle and sheep feeding. Either cabbages, common turnips or some of the early maturing hybrid

turnips may be used during September, October and November. Hybrid turnips and rutabagas may be used in November and December, mangels or half-sugar mangels being used the rest of the winter. Rutabagas may be used for hogs, especially for wintering sows. Carrots may be grown for horses.

Essentials for a high yield:

1. A proper rotation. Mangels grown continuously on the same land for four years yielded 9.6 tons of roots containing one ton of dry matter, while those grown on an adjacent plat which had been in a rotation of corn, etc., yielded 34 tons containing four tons of dry matter, a gain of three tons of dry matter per acre.

2. Early sowing.

3. A uniform stand. The number of plants suggested per acre, is: half-sugar mangels, mangels, rutabagas and hybrid turnips, 25,000 to 30,000; carrots, 40,000 to 60,000. (See table Bul. 243, pp. 97-98.)

The varieties recommended:

Among the mangels, all of the long varieties seem to be able to produce good yields but have various defects. The Globe and Tankard varieties usually contain a higher percentage of water and are low in dry matter content. (See p. 129.) Two half-sugar mangels, Vilmorin Half-Sugar Rosy, and Carter Half-Sugar, are recommended as suitable stock to use for breeding American strains.

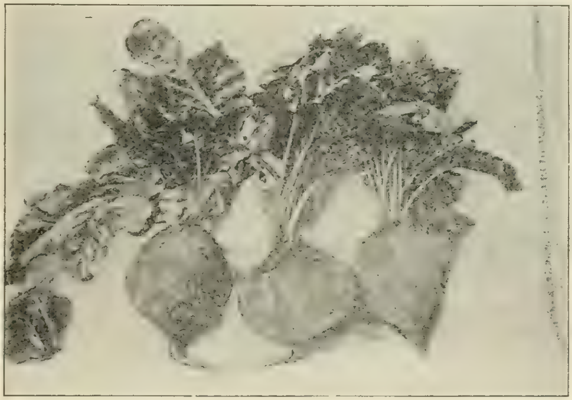

FIG. 39.—*Yellow Globe mangel. A good yielder. Some specimens eight inches in diameter. Because of its shape it is better suited to shallow soils than the long kinds.*

Sugar-beets, although rich in dry matter, are generally so much more expensive to harvest that the writers are not prepared to advocate their extensive use for stock-feeding.

Carter Holborn Elephant, the Kangaroo Rutabaga (which originated in Canada) and Garton Superlative are recommended on account of their comparative freedom from fibrous roots and their uniform good shape. In yield the varieties were nearly all equal. (Fig. 49.)

The Yellow Aberdeen hybrid turnip proved to be the best to grow for early fall use. Garton Pioneer is later and can be stored as well as rutabagas. In both years it outyielded the rutabagas. (See p. 129.)

The Mammoth Improved Green Globe and White Egg are recommended as useful turnips for early fall use.

Carter 100-Ton carrot was the best variety for clay loam soil. Lobberich Agricultural Carrot did equally well on clay loam and gravel loam. Altringham seems to be useless on the heavy clay loam. Giant Wiltshire and Orange Giant gave good yields on the heavy clay loam, but were difficult to harvest, because they broke off so readily; they are better adapted to deep, friable loams. (Figs. 55, 60.)

FIG. 40.—*Golden Tankard mangel. Though its yield of fresh substance is not so high as some others, yet it yields well in dry matter. Shape variable.*

White Vienna and Carter Model kohlrabi were of equal value. (Figs. 53, 54.)

Hollow Crown parsnips gave a poor yield (eight tons) during the three years.

TABLE SHOWING YIELD OF FRESH AND DRY SUBSTANCE AND PERCENTAGE OF DRY SUBSTANCE IN VARIOUS VARIETIES OF ROOTS.

	Years grown.	Yield per acre, tons.	Dry matter per cent.	Dry matter per acre, tons.
Mangels.				
Norbiton Giant	3	25.2	11.22	2.76
Garton Long Red	3	28.1	10.18	3.15
Golden Tankard	3	24.4	11.31	2.85
Yellow Globe	3	33.	8.43	2.77
Chirk Castle	3	29.6	11.91	3.59
Carter Red Emperor	2	16.1	9.74	2.41
Half-Sugar.				
Vilmorin Rosy	2	28.	10.98	3.11
Vilmorin White	2	25.8	10.89	2.80
Carter Half-Sugar	2	25.2	11.74	2.97
Harris Half-Sugar	2	27.1	10.71	2.87

TABLE SHOWING YIELD OF FRESH AND DRY SUBSTANCE, ETC.—Concluded

	Years grown.	Yield per acre, tons.	Dry matter per cent.	Dry matter per acre, tons.
Sugar-Beets.				
Kleinwanzlebener	3	16.2	20.04	3.71
Danish Improved	2	27.2	12.14	3.28
Lane Improved	2	27.4	12.52	3.48
Rutabagas.				
Garton Monarch	3	23.6	9.03	2.16
Improved Purple Top	3	24.	9.64	2.28
Bronze Top	1	14.6	9.12	1.3
Kangaroo	2	24.8	10.57	2.63
Holborn Elephant	2	24.1	9.44	2.28
Imperial Purple Top	1	22.7	10.11	2.29
Superlative	1	29.9	8.76	2.62
Kohlrabi.				
Carter Model	2	22.4	8.92	2.
White Vienna	2	20.5	10.11	2.07
Goliath	1	18.1	8.91	1.61
Turnips.				
Golden Ball	Res	ults vitia	ted by so	ft rot.
Redtop White Globe	2	23.7	12.9	3.05
Mammoth	2	19.	7.37	1.45
Improved Green Globe	2	17.8	8.27	1.53
Cowhorn	1	14.5	7.94	1.15
White Egg	1	17.2	8.55	1.47
Hybrid Turnips.				
Pioneer	3	25.9	9.46	2.44
Yellow Aberdeen	3	16.6	8.52	1.42
Commonwealth	2	20.	7.33	1.45
Lightning	2	19.	8.04	1.52
Carrots.				
Lobberich Agricultural	3	13.	12.2	1.59
Giant Wiltshire	2	11.3	11.02	1.23
Carter 100-Ton	2	19.2	10.21	1.96
Altringham	2	7.1	12.16	.86
Orange Giant	2	15.1	10.31	1.55
Danvers	1	13.5	9.99	1.35

II—Descriptions of Different Kinds of Roots and Methods of Growing Them. (pp. 130-163.)

I—MANGELS.

Before proceeding to describe the different varieties of mangels, it is essential that the terms relating to their form and color be defined. Knauer, the eminent breeder of sugar-beets, devised a more elaborate classification, for which see "Sugar-beet Seed," L. S. Ware, 1898.

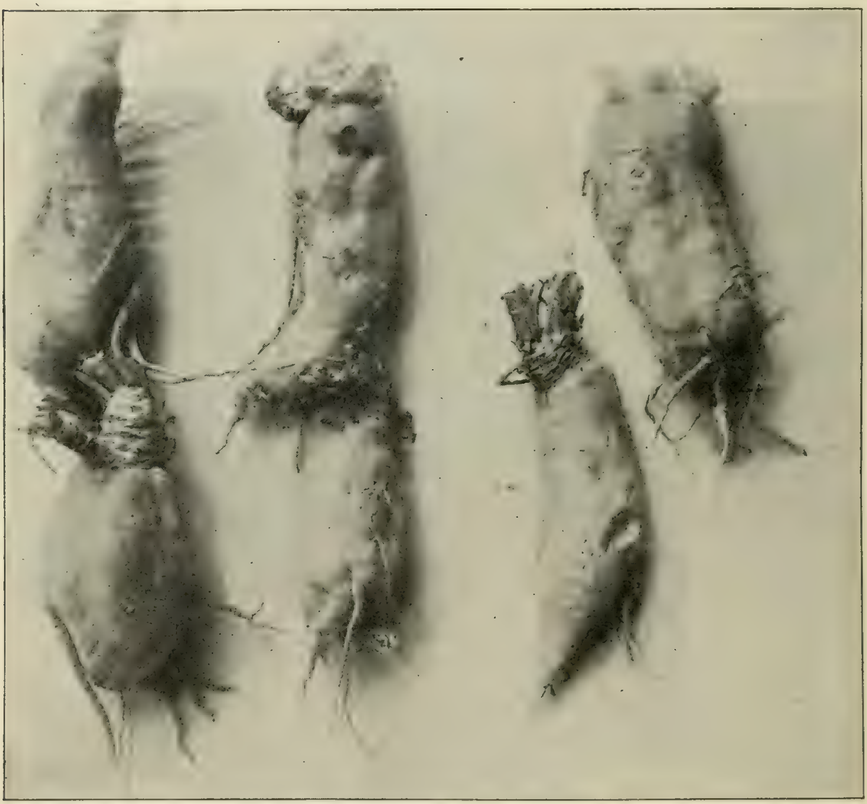

FIG. 41.—*Cowhorn turnips, to illustrate distinct shape. Not a very good yielder, subject to dividing roots and also to soft rot.*

Five shapes are recognized—the long, half-long, ovoid, tankard, globe; and a sixth shape, the cowhorn, is still grown in Europe. The color of the skin may be white, pink, red, orange or yellow, golden, purple or black.

The long-shaped varieties are at least three or four times as long as they are broad at their greatest diameter, and frequently taper to the crown and tip of the root. Red is the most common color, although

yellow, white and purple are met with. From one-half to two-thirds of the root may be below ground; thus in a root 20 inches long, 10 to 13 inches will be below ground. This is important as it limits the successful growth of such varieties to deep friable soils which can be fitted to a good depth.

The half-long tapers from the shoulders to the tap root, and is like the long in appearance but the length is less than three times the greatest width.

The ovoid is frequently about two or three times as long as it is broad, and tapers to the crown and the tip of the root. The skin is of various colors, red, yellow and orange being most common. About one-half the root may be below ground, hence, owing to their short length, they are better fitted for shallow soils than the long forms.

The tankard is about two to three times as long as broad and differs from the half-long in that its width is almost uniform throughout its entire length. The Golden Tankard is one of the most common, although the Crimson Tankard, which has a crimson or rose-colored skin, with crimson rings in the flesh, is also well known. Four inches in diameter and 10 to 11 inches in length is a common proportion. Generally rather more than half of the root is above ground, and in roots above average size, for this district, but five inches will be below the surface.

FIG. 42.—*A typical half-sugar mangel. A good type to grow. It does not vary in yield so widely as do regular mangels, and it yields well in dry matter. Background in six-inch squares.*

The globe form is spherical or nearly so. A common size in this locality is from four to seven inches in diameter. The Yellow Globe is the most common, although red and orange varieties are frequently met. Frequently two-thirds to four-fifths of the root is above ground, hence this form is particularly adapted to shallow soils. It is readily pulled.

The cowhorn, which is a long type but curved like a cow's horn, is still grown in parts of Europe.

The mangel is frequently referred to as a " root." Strictly speaking it may be called a modified stem and primary root which are closely united. Generally the following parts are to be recognized:

The neck is the part that bears the leaves. This may be long, medium or short. The aim of the breeder or grower is to have it as short as possible, the flesh firm and solid, with no tendency to sponginess or hollowness. Generally speaking, the mangel is a biennial, that is, it lives two years; the first year it stores up food in its thickened stem and root, which is used the second year in producing seed. Some plants try to produce seed the first year, in which case the neck rapidly elongates and the plant blooms and little or no thickening of the stem or root takes place; this also occurs in other types of root-crops.

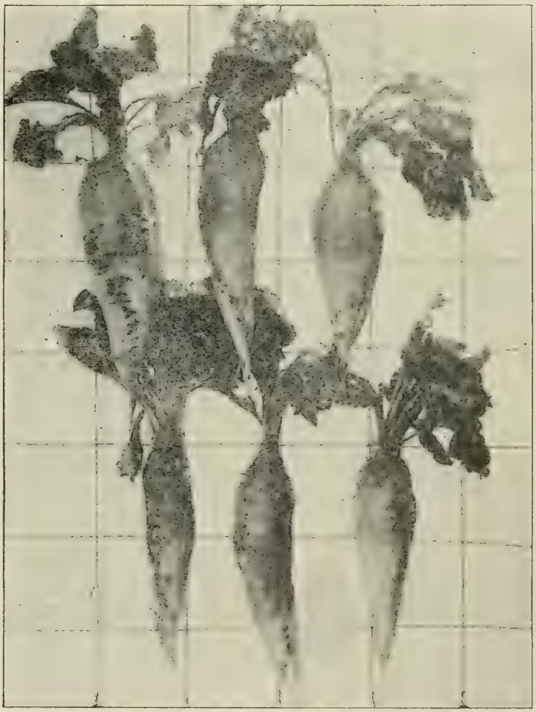

FIG. 43.—*Vilmorin Rosy half-sugar mangel. One of the best half-sugar mangels. Though it grows into the ground, yet if planted on light soil it is easily harvested. Six-inch squares in the background.*

The neck contains less sugar than the remainder of the plant and more indigestible nitrates and other compounds, hence its size should be restricted. Its function is to support the leaves, and a flat crown can carry a large rosette of leaves.

The shoulders are more prominent in some varieties than in others. They consist of the upper part of the stem and do not bear leaves. They may be square or round, prominent or slight.

The crown. The shoulders and neck constitute the crown, which is removed in the case of sugar-beets before using them for the manufacture of sugar. When but one shoot or neck arises from the crown it is said to be single. If several shoots arise it is said to be multiple. This is frequently seen and is undesirable. The smallest shoots grow largely

at the expense of the food already stored in the stem and root and reduce the feeding value of the root, hence plants showing these characters should never be kept for breeding purposes.

The stem or hypocotyl. This part of the mangel is rich in nutrients. It varies in length in different varieties. In some varieties it is above ground, in others, as in the Kleinwanzlebener sugar-beet, it is below ground. It is an observed fact that those plants having a large part of the hypocotyl below ground are richer in sugar and of better feeding value than those having a large part above ground. Roots rarely arise and grow from the hypocotyl.

The primary root appears as a continuation of the hypocotyl. It should terminate in a single small tap root, when the root may be said to be smooth; secondary roots, prongs or forks are undesirable, not only because of increasing the cost of harvesting, but because they indicate that the plant is of a coarse and fibrous nature, and the amount of soil they hold renders the roots undesirable food for stock. Such roots are described as forked or rough in contradistinction to smooth.

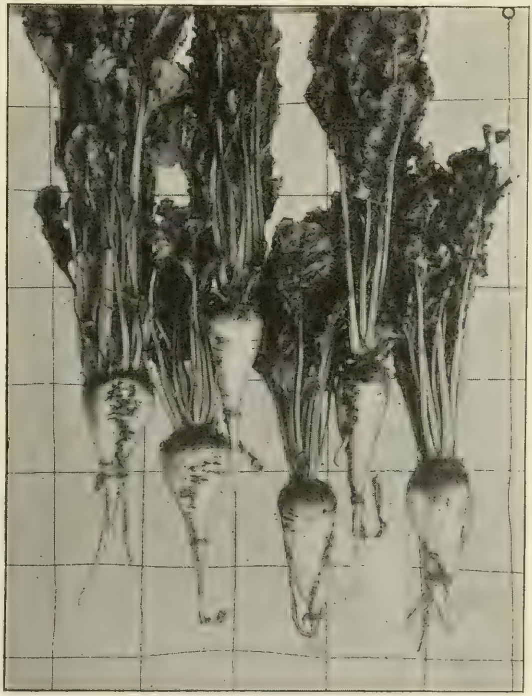

FIG. 44.—*Kleinwanzlebener. One of the best sugar-beets, although it grows well into the ground and is expensive to harvest. Six-inch squares.*

The primary root is characterized by two depressions running lengthwise down the root, and opposite to each other; these are known as the dimples. They should be vertical and not too deep. In some cases three dimples may be seen.

The lateral roots spring from the dimples; they should be fine, fibrous and fairly abundant, and their origin confined to this area, as when they spring promiscuously from the surface they render the root more difficult to harvest and carry much more soil into the root cellar.

The fibrous root system breaks off when the plants are harvested. It is quite extensive and where opportunity permits, it will fill the soil to

a great depth. In some cases drains four or five feet below the surface have been blocked by the roots of a mangel.

The flesh is seldom of a uniform color. A transverse section of a mangel shows a series of concentric rings of firm tissue alternating with rings of softer tissue. The sap of the latter is often colored; thus it may be crimson in the long red mangel or golden in a Golden Tankard mangel, while in a sugar-beet or half-sugar mangel it may be white. There does not appear to be any correlation between the color of the flesh and the sugar content or the feeding value, as has been asserted. Six or seven complete rings are often formed in as many months of growth. The different parts of tissue which go to make up a ring vary in their sugar content and feeding value, the cells constituting the ring itself, known as the vascular ring, being richer in sugar than those cells situated midway between two rings. The statement is made that the richest mangels are, therefore, those in which these vascular rings are most closely packed together and in which the area devoted to cells poor in sugar is reduced to a minimum, and that, therefore, given two roots of equal diameter, the one having the greatest number of vascular rings will be of the greatest feeding value. Within certain limits the above is probably correct; how far it may be carried the authors are not yet prepared to say. Some European growers consider this character in the selection of sugar-beets. (Sugar-beet Seed, Lewis S. Ware, 254, 1898.)

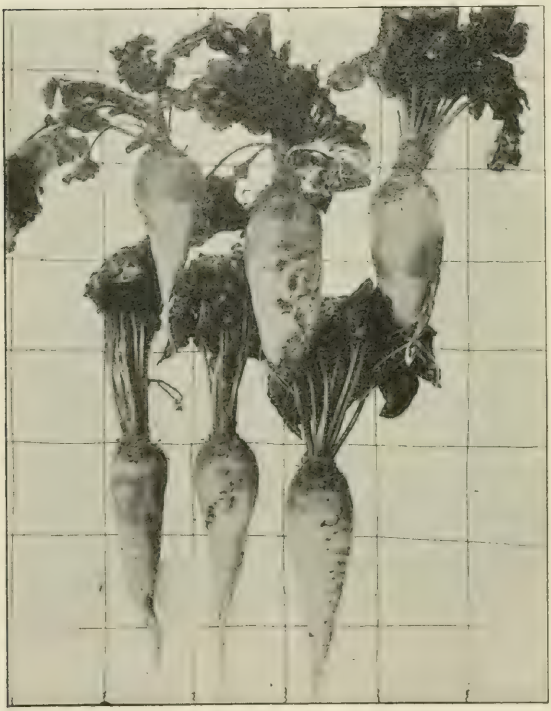

FIG. 45.—*Danish Improved sugar-beet. It does not grow so deep in the ground as the preceding. All sugar-beets are rather poor keepers for late winter feeding. Six-inch squares.*

It seems to the writers that the search for roots containing a higher proportion of dry matter is commendable, but that the sugar-beets as now

grown possess so many drawbacks that their use is not to be recommended. There are individual roots in almost any variety of mangels which contain 18 to 20 per cent. of dry matter and it is thought that the selection of such and their perpetuation is the line that should be followed. It would seem that the desideratum in mangels for the present is one of uniform good size, 6 to 8 pounds, containing 20 per cent. dry matter, which will not lose much in weight when stored for 4 or 5 months; one that has shallow dimples; a single crown; a minimum of neck; a single tap root; is free from forking and masses of strong fibrous roots which adhere to the tuber and render the crop difficult to harvest and carry considerable soil into the cellar; has good disease-resisting power; produces a reasonable quantity of vigorous seed; it may be of any shape or color which is easiest to secure; all plants should be uniform in these characters.

Soils for mangels:

Mangels may be grown on almost all productive soils. Deep loams are considered best, and are necessary for the production of heavy yields of the long varieties. The Globe and Tankard varieties may be grown on the lighter, shallower soils.

FIG. 46.—*Improved Purple Top rutabagas. One of the best yielding kinds. Its long neck and divided roots are against it, however.*

Climate:

Mangels, like sugar-beets, do better where there is considerable sunshine. Provided there is a good supply of moisture in the soil they will thrive in a warm, dry climate once they are established. They can withstand drought far better than most other root-crops.

Rotations for mangels:

As mangels are an intertilled crop, they may be grown between two grain crops or after another intertilled crop which has been heavily manured, as cabbages. In some places success has been attained by growing them after clover which has been down for one year. As they are not harvested until late in the fall the grain crop

best suited to succeed them will be oats or corn. If oats follow, the mangel tops should be spread uniformly over the land and plowed under in the fall. Failure to spread them uniformly will cause an uneven grain crop, as the tops are a valuable manure.

Preparation of soil for mangels:

Deep fall plowing is advisable, with a cross plowing or a deep disk-harrowing in the spring. No crop responds more readily to good tillage than the mangel and no crop will be more discouraging to the man who but half prepares the land. Ten to twelve tons per acre of barn manure should be applied to the land in the fall, previous to plowing; this may be supplemented with fertilizers in spring if desired. Before the seed is sown the land should be well fitted with the disk and spiked-toothed harrows. The successful grower will give five or six harrowings if necessary to make the seed-bed fine. Previous to the last two harrowings, apply 240 to 280 pounds of acid phosphate and 100-120 pounds of nitrate of soda per acre, and 100-120 pounds muriate of potash; these should be mixed together just before application; the mixture should be applied early in spring. The fertilizers will stimulate the young plants. In some cases, 400 to 500 pounds of salt per acre are applied. If the land has not been recently limed, an application of 1,500-2,000 pounds per acre will often be profitable.

FIG. 47.—*Garton Monarch rutabagas. The roots are generally uniform in size and shape and are solid. It is somewhat affected by clubroot disease.*

Seeds and seeding for mangels:

What is sold in commerce as mangel seed is really the fruit. It is sometimes called capsule or "bolt." If opened it will be found to contain one to five small seeds, two to three being most common. (Page 119.) One hundred capsules should produce 150 to 175 plants and as two or three plants sometimes grow close together from one capsule it requires hand labor to thin the plants. An attempt to remedy this has been made by cracking the capsules into pieces, so that but one seed would

be sown in a place, but this method does not seem to be making much headway. The U. S. Department of Agriculture is now breeding sugar-beets with but one seed in a capsule. The smallness of the seed must be considered when sowing, as it is easy to sow it too deep. On the University farm three-quarters of an inch deep seems to be ample, and one and a half inches is too deep. Attempts have been made to hasten germination of the seed by soaking the seed in warm water and other substances, previous to planting, with varying success. Unless leaf-spot (Cercospora beticola) be prevalent, in which case it may be advisable to try some other root-crop, it is essential that mangels be sown early; the end of April or the beginning of May is late enough. From six to eight pounds of good seed are required per acre, although in the case of sugar-beets 12 to 15 pounds are often sown. The quantity of seed necessary is controlled by two factors; the number of capsules and seeds in a pound, and the number that will grow. The number of capsules in a pound varied from 18,000 to 36,000 in 1905, in 15 varieties of sugar-beets and mangels, the germination power from 73 per cent. to 185 per cent. A drill sowing four rows at a time is much used; although the grain drill will do fairly well. A seven-inch 11-hoe drill can be used for sowing the seed, in either 28 or 35 inch rows.

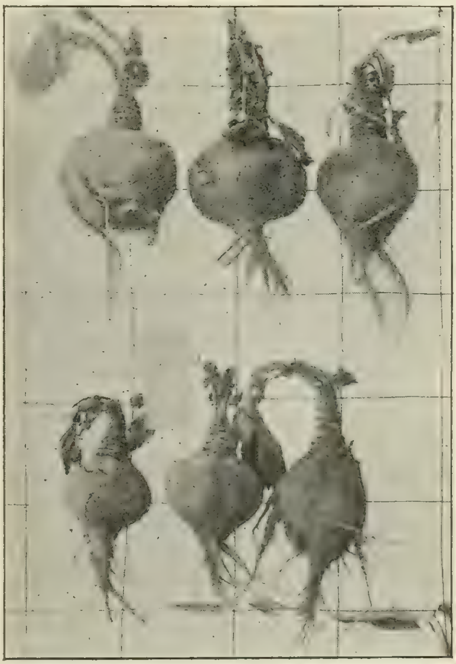

FIG. 48.—*Harris Imperial Purple Top rutabagas. Although not a high yielder, yet it was free from insect attacks. This seems to be a promising variety. Background with six-inch squares.*

Width of rows and thinning for mangels:

It is recommended that the rows be not less than 30 inches apart, as narrow rows do not facilitate the use of two-horse cultivators. The aim should be to grow the maximum number of plants per row, as the reduction in cost of production by the usage of wide rows will compensate for any reduction in yield due to fewer plants per acre. As soon as the plants have four leaves they may be bunched; that is, take a hoe five or six inches wide, go down the rows and chop out all plants except

a little bunch every six, eight or ten inches as required. After this they should be singled to one plant every six to ten inches, depending on the variety; the globes and tankards require rather greater width in the row than the long varieties. It is important that but one plant be left in a place, otherwise small, distorted roots will result. It is equally important that the thinning be done while the plants have but three or four leaves and before they become "drawn." If they are checked in any way at this time, the injury is permanent.

Cultivation of mangels:

As soon as the rows are discernible, shallow cultivation should be given. The cultivator should have shields to prevent soil being thrown on the young plants, and yet permit tillage close to them. If the stand is good the weeder may be run across the rows to destroy small weeds and aid in thinning. As soon as the plants are thinned, or before, if they appear stunted, they should receive an application of 50 pounds of nitrate of soda per acre, which may be mixed with 50 pounds of acid phosphate, or salt or sand to give it bulk and aid in distribution. This should be applied when the leaves are dry, since if it comes in contact with wet leaves it will injure them; and it should be applied close to the plants and harrowed in. At this stage the plants grow slowly and no pains should be spared to push them on with tillage and fertilizers and get them ahead of the weeds. A second or third application of nitrate of soda at intervals of ten to fourteen days is generally profitable. When thorough preparation has been given, shallow cultivation to keep the weeds in check is deemed advisable. The cultivator should go through the rows about every ten days to maintain a mulch, until the tops meet in the rows, which will prohibit further intertillage. It has been suggested to run the shovel-

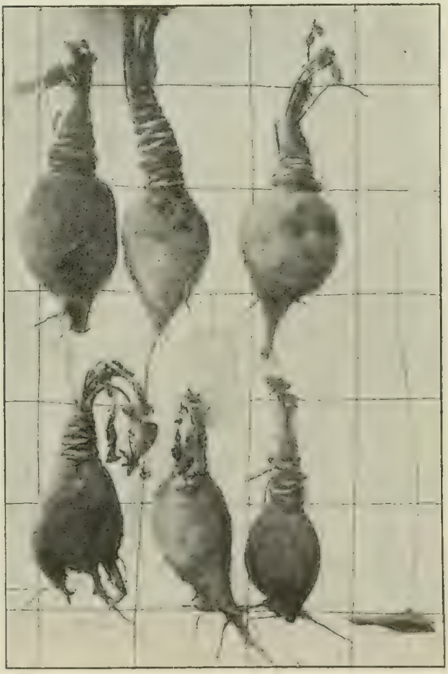

FIG. 49.—*Kangaroo rutabaga. A fair yielder. Flesh of good texture. Requires early sowing. Six-inch squares.*

plow through the rows at the last cultivation to increase the proportion of the root below ground. Whether this practice will answer or whether it is commendable or not, the authors are not in a position to state.

Harvesting and storing mangels:

Mangels should be harvested before severe frosts occur. The withering of the outer leaves is taken as an indication of cessation of growth. This frequently occurs about the middle of October and no time need then be lost before storing. The roots should be pulled up with as little injury as possible and the tops twisted off. Care in handling is requisite as, although mangels are the first roots to be stored, they are the last to be used, and their keeping quality should not be reduced wantonly. In this state a root cellar is perhaps the best place in which to store them. It should be dry and well ventilated, as the roots suffer if these points are neglected.

Yield of mangels:

The average yield of mangels is generally from 16 to 29 tons, although during the past three years several varieties have yielded at the rate of 40 tons per acre. The average yield of dry matter per acre in the past three years was between two and four-tenths and three tons per acre. In the case of sugar-beets, yields of 20 tons of beets containing four to four and five-tenths tons of dry matter were secured, while the yields of half-sugar mangels ranged between the yields of mangels and sugar-beets.

FIG. 50.—*Rutabagas when planted late do not develop well for stock-feeding. This is a poor type of root.*

Composition and feeding value:

The amount of dry matter in the mangels usually varies between seven and fourteen per cent., and there is generally as great variation between individuals of a variety as there is between different varieties. This is true in regard to the weight of individuals, their dry matter and sugar content. During the year 1904, on the University farm the dry matter content

varied between 9.56 per cent. and 16.01 per cent. in the nine varieties grown. The variety, Norbiton Giant, was near both extremes with 9.55 per cent. and 14.88 per cent. of dry matter. Usually about half of this dry matter is sugar, the percentage often varying between three and eight per cent. In nine varieties grown on the University farm during 1904, it varied between 4.23 per cent. and 8.99 per cent.; in this composition Norbiton Giant

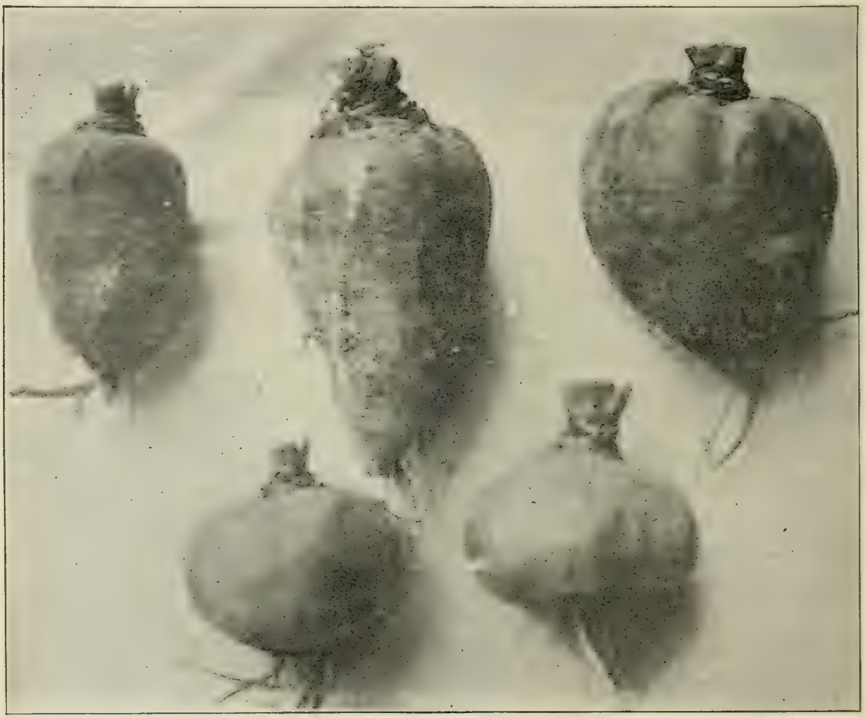

FIG. 51.—*Mammoth turnip. A good yielder, but having a tendency to pithiness. Lower row planted late.*

heads the list, and in another case is found not far from the bottom with 4.77 per cent. It is not the root which gives the greatest total yield, nor yet the richest which is the best to grow, but the one producing the largest amount of dry matter per acre at the least cost. It is not considered advisable to feed mangels to stock until after Christmas as they appear to contain some ingredient which produces diarrhea in animals, but which disappears when the roots are stored. This substance is thought to be a nitrate, although some authorities suggest that an oxalate or perhaps both may cause the trouble. It is known that nitrates are

present to a considerable extent in freshly harvested roots and that they tend to disappear in storage.

Few British farmers feed mangels whole, except occasionally to horses and hogs. For sheep they are cut up into finger pieces, like French fried potatoes, or sliced. They are sometimes prepared in this manner for cattle but are more often pulped, that is grated down to irregular shaped pieces of about five-eighths to three-fourths of an inch in diameter. This is frequently done twelve hours before they are required for feeding and during this time they are left mixed with chaffed hay or straw cut about two inches long, and left to heat. In making the pile, a layer of chaffed hay or straw is laid on the floor, then some mangels, then chaffed hay or straw and so on. In twelve hours the mass has become warm, the meal and ground grain or whatever concentrate is being used is mixed uniformly through the mass and it is then fed. No more is mixed than will be required at the time.

FIG. 52.—*Aberdeen yellow hybrid turnip. A good yielder with solid flesh.*

In some cases known to the writers, mangels grown on sewage-irrigated farms have developed an unfavorable fermentation if handled in the above way; the best way to handle such is to pulp them a few minutes prior to their being fed.

The same general remarks apply to sugar-beets and half-sugars. See table, p. 129, for yields.

Rotation of crops as a check to leaf-spot:

In 1904 some interesting differences were observed in regard to the susceptibility of mangels and sugar-beets to leaf-spot when grown continuously on the same land for four years and when grown in a rotation with other crops. The observations were made on sections 1, 4, 7 and 10 which were sown to mangels May 6 and 7. As section 10 was not so large as the other three it is discarded for the present. (See Bul. 243.)

Sections 1 and 4 were on land which had been growing beets for the last three years 1902, 1903, 1904; in 1903 the beets suffered from leaf-spot but yielded at the rate of 17 tons per acre. Sections 7 and 10 were in corn in 1903.

So far as could be judged, the plants on all sections had a uniform start, but those on sections 1 and 4 soon showed signs of disease and this, with the attack of the flea-beetles, killed many of them or injured them so seriously that the filling in of the blank spaces was almost a second sowing. The plants on section 7 grew vigorously and got ahead of the flea-beetle attack. The same was true of those on Plat 10. The results were as follows:

YIELD OF FIVE VARIETIES OF MANGELS WITH AND WITHOUT ROTATION.	Average, sections 1 and 4, no rotation.	Average, section 7, rotation.	Gain tons.
Total yield per acre, tons	9.6	33.6	24
Dry matter per acre, tons	1.0	4.0	3

Taking the variety Norbiton Giant, which occurred in all four plats, we find that the results are:

YIELD OF ONE VARIETY WITH AND WITHOUT ROTATION.	Average, sections 1 and 4, no rotation.	Average, sections 7 and 10, rotation.	Gain tons.
Total yield per acre, tons	11.9	35.1	23.2
Dry matter per acre, tons	1.4	2.9	2.5

If we regard the land as fairly uniform, then this would indicate that there is a distinct gain in the rotation of crops, from its influence as an agent in restricting the spread of diseases.

Results with leaf-spot in sugar-beets:

In 1904 the leaf-spot disease began its ravages the first week of September and spread rapidly for a few days on the plat which had been in beets without rotation. It was observed that the part which had been under rotation was almost free from leaf-spot and this led to the determination to ascertain its influence. It was presumed that

the loss of leaf surface by the plants might have an influence on the sugar content and dry matter content of the roots. Part of the rotation plat kept almost free from leaf-spot. No efforts were made to check the spread of the disease.

The results showed a gain of 1.9 tons in yield, or 21 per cent. on the rotation plat. This, with the higher dry matter and sugar content, ensured a yield of half a ton more dry matter per acre or 24 per cent. increase. It is noteworthy that this increase was entirely in sugar, the increase in this ingredient being 45 per cent. The increase in dry matter and sugar was well maintained from the earliest harvesting until the last. The number of plants per acre was fairly uniform throughout the plat, averaging 34,000. The yield of tops per acre weighed immediately after harvesting was a little heavier than the yield of roots, and the amount of foliage on the "no rotation" portion was somewhat greater than on the "rotation" portion.

FIG. 53.—*Carter Model kohlrabi. A variety heavy in dry matter. Adapted to a wider season of sowing than rutabagas and mangels. On a 6-inch screen.*

History and development of the mangel:

Von Thaer states that the mangel wurzel in his time was a kind of red beet and that it was a mongrel between the red beet (garden type) and the white beet, a cross which might readily occur.

In the 18th century it was popularly known in Germany as "the root of scarcity," and it was under this name that it was introduced into England by Dr. John Coakley Lettson about 1785. About this time, 1786, Mr. Thomas Boothby Parkins transmitted an account of the root from Metz to the London Society, with seeds. McMurtrie states that the variety sent was that named Disette by Vilmorin, which was the long

FIG. 54.—*White Vienna kohlrabi. Well worth trial on good soil. Six-inch squares.*

mangel type. Although exact evidence is lacking, it would seem that at this time the mangel had not been in cultivation more than 50 years, and probably less. It is not mentioned by Miller in The Gardner's Dictionary of 1752. It is evident that the mangel reached America about the time it reached England. Samuel Deane, 1790, and John Spurrier, 1792, were enthusiastic about the new plant; they grew roots weighing seven lb. each and secured a yield of 14½ tons per acre. In 1789 James Adam gave details in regard to the crop, and in 1805, R. W. Dickson gave a very good account of the methods of culture. Several experiments were conducted by individuals, but the crop was not generally grown.

In 1797, Archard of Berlin announced the discovery that the sugar of beets and mangels could be extracted, it having been shown by Marygraff (or Maregraff) of Austria in 1747 that they contained crystallizable sugar. The latter had stated that the root of the white beet was the richest in sugar. The first sugar-beet factory was erected in Silesia in 1805. Later, with the closing of the French ports to sugar from the West Indies and the offer of bounties on home-made sugar, the development of the culture of mangels for sugar-making was stimulated. But the industry suffered many vicissitudes before it became established. It was soon found that mangels containing red coloring matter were handled with more loss than white-fleshed ones, because in the removal of the coloring matter, some sugar had to be sacrificed. Hence, white or yellowish-white mangels were developed and from this time on the term "white" when applied to mangels meant a very different plant from the white beet of the garden. The name "white beet" continued to be used for many years as a synonym for Chard. Vilmorin used mangels from time to time in crossing and developing sugar-beets.

The mangel was tried in parts of England, with many failures. It had to compete with the turnip; with the rutabaga, also a recent introduc-

tion, but becoming well established; with the cabbage, and in some places the carrot; and it is well to remember that these plants had been grown but a few decades for stock-feeding purposes. A very good example of the length of time required to distribute an improved type is furnished in the case of the garden beet. The "improved" beet was in the hands of Ruellius in France, in 1536; Matthiolus of Germany in 1558, Lobel in England in 1576 and also in Italy, yet in spite of this general distribution we find that Blackwell in his Herball of 1758 figures an unimproved form as then common, the type being Beta nigra, an unimproved form shown by Dalechamp as early as 1587. It would seem that although the improved form existed over 350 years ago, the unimproved was still grown in places as recently as 150 years ago. It took, then, 200 years for the better type to displace the poorer one.

FIG. 55.—*Giant Wiltshire carrot. Grows rather deep. Should be planted early. Background, six-inch squares.*

It is evident, that the development of mangels as feed for stock is quite recent. Arthur Young, 1809, states that in England "they are very little cultivated at present," but that owing to the fact that Sir Mordaunt Martin of Norfolk was growing them satisfactorily and finding them useful for cows it was proper to mention them in his work. The Complete Farmer in 1807 mentions the same facts and states that the root had not met the expectations of those who tried it, the chief objection being "the great expense of its culture, it being liable to degenerate and the fibrous nature of the roots rendering their preparation as cattle food troublesome." In the above work, but one variety is mentioned, the red beet, but under the title "beets," mention is made of the white beet which is stated to contain considerable saccharin matter but which had not been used for stock feeding (in England). A pale yellow variety was also grown. It took

about 60 years of experimenting for the English farmer to find the place for mangels. They began to displace the rutabaga, turnip and cabbage on some of the farms about 1830 to 1840, but it made comparatively slow progress and in America it has made little headway. Finally it was found that its good keeping quality made it an excellent succulent feed for the last months of winter and those of early spring. A place having been found for it, its improvement began. Up to this time its use in France and Germany was much more extensive than in England. In these countries the development of the beet-sugar industry directed attention to the subject and several eminent workers took part; among these may be mentioned the Vilmorin family of France whose work in the development of better beets is so well known. Lawson in 1836 mentions the common red mangel as the one generally grown, also Red Globe, Yellow or Golden mangel, and the white mangel used for sugar-making. In 1851 several varieties of mangels were grown in Great Britain, the Long Red being the one most generally raised; other varieties were Red Globe, Long Yellow, Yellow Globe, Lewin's Orange. The White Globe and Long White mangels, which were grown for sugar-making in France, yielded about half that of the other varieties. Grant described five varieties of mangels and four of sugar-beets in 1867, although he states that there are many more; and he gives details in regard to culture and the yields. For over 115 years mangels and sugar-beets have been grown more or less sparingly in America. In this time most of the varieties sown have been European, and the seed has been European grown. Recently it has been shown that sugar-beet seed can be grown successfully in this country and the same is true of mangels.

FIG. 56.—*Yellow Belgian carrot. A good stock carrot, but its roots are sometimes non-uniform, and it is not adapted to a wide variety of soils.*

Improvement of mangels:

The first means used in the improvement of the beet was giving the plant a better environment,—fertilizing and cultivating the soil, ameliorating the moisture and temperature conditions. This induced greater variation in the plants, and those plants showing characters considered to be of value were selected for seed production. Modification of the environment is still an important factor in inducing variation. Selections were made from time to time for such characters as greater size and thickness of the root; regularity of form; color; amount of the root below the surface of the ground; and in the case of mangels, selection for these external characteristics seems to have been the only selection which has been given until very recently.

FIG. 57.—*Scarlet intermediate. A good carrot for table use, but the seeds do not germinate well under field conditions. Its yield is small, and the growth slow.*

Until 1850, no other methods were used in the selection of "mother" beets of either mangels or sugar-beets, but about this time it became evident that varieties of mangels, like varieties of sugar-beets, were not of equal value. Anderson of Scotland, 1830, found that three varieties of mangels which he analyzed varied widely in composition. Dubrunfaut in 1825 and others insisted that some method for determining amount of sugar in the beet should be worked out, and again in 1850 Ventzke pointed out that sugar-beet growers were selecting "mother" beets for non-essentials, as external characters, and neglecting this important thing, sugar. During this interval considerable thought was bestowed on the problem, and Vilmorin in the same year (1850) began selecting by means of specific gravity determinations, assuming that roots of the highest specific gravity would be of the most value. This he soon abandoned, and, although it is still employed by some seed-growers in Europe, selection was made by testing the specific gravity of the juice. The interest shown in the topic can be realized from the fact that Vilmorin read three papers on the subject in the years 1850, 1851 and 1856. In 1867 Scheibler pointed out that this latter method was

inaccurate, and Marck suggested the use of the polariscope for determining the actual percentage of sugar in the juice. This method slightly modified, is still in use.

In Germany an actual average increase of 45 per cent. in sugar was made in 30 years and, using the average of the area grown in the United States, there is an increase of over 50 per cent. in 44 years and every prospect of maintaining this rate of increase for one or more decades. In 1904 the actual yield of sugar from a ton of beets in the United States was 230 lb. In Europe in 1805 and for some years later it was about 100 lb. from one ton. This increase is due to better methods in manufacture and to better beets. Some authorities go so far as to say that the latter factor is responsible for an increase of 100 lb. per ton, or an average of one lb. per year for 100 years, a remarkable gain, since it costs no more to grow the good beet to-day than it would to grow a poor one, and it is 100 per cent. better.

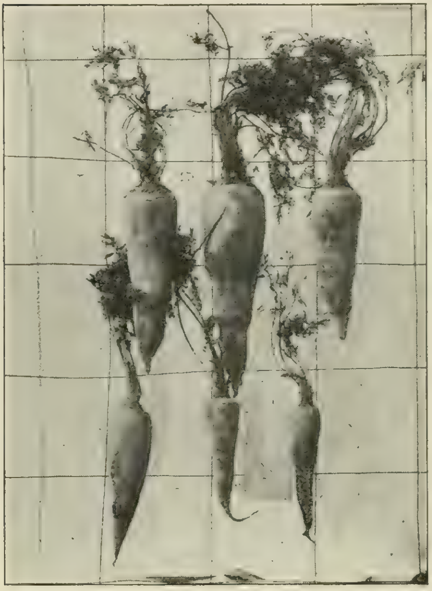

FIG. 58.—*Carter 100-Ton carrot. One of the best yielding stock varieties. It is liable to crack, however, on clay soils when sown early. May do better on light soils. Six-inch squares.*

In contrast with these figures, it is of interest to compare the composition of the mangels for the past 50 years in England, since more attention has been devoted to this crop in England than in this country; and since the dry matter content of the root appears to decide its value, this character is used for consideration:

Year.	Dry matter per cent., England.	Cornell Experiment Station.	Year.	Dry matter per cent., England	Cornell Experiment Station.
1852	11.5		1902	12.9	
1880–4	10.97		1903	11.8	
1885–9	11.78		1904	12.3	9.56–16.01
1890		9.68	1904 at Cambridge Univ. Eng.	10.7–20.7	
1890–4	13.04		1904 in var. Norbiton Giant		9.56–14.88
1895–1900	11.80		1904–5 Av. 152 analyses		11.6

This table shows that the average composition of the mangel of to-day is practically the same as it was 50 years ago. We are forced to acknowledge that there has been no improvement in the feeding value of mangels in the past 40 years, although the sugar beet has been increased 50 per cent. in its value for sugar production. In the latter case there was a recognition of the fact that sugar-beets were grown to produce sugar and a method was discovered which would measure the amount of sugar in the root. In the latter case there has been no general recognition that dry matter was the object sought and consequently there has been no methodical breeding to secure it.

Naturally, the question arises, "Is the percentage of dry matter in mangels the measure of their feeding value?" In view of our present knowledge the writers have accepted as proved that it is, and the methods for the improvement of the mangel now suggested are made on this understanding. It is probable that in 1850 sugar-beets containing 20 per cent. of sugar existed, but there was no practical means of detecting them. It is also equally certain that mangels containing 20 per cent. of dry matter exist to-day, and that this character can be transmitted as easily as that of high sugar content. The only difficulty with most seed-growers has been a reliable means for ascertaining which of the mangels contain the high dry matter content. Considerable work in this direction has been done by Messrs. Wood and Berry at Cambridge University, England. They have shown that by extracting a core from a mangel and by determining the dry matter in this sample, they had a comparatively close indicator of the composition of the root. The root varies in composition in different parts, but a sample taken with a cheese trier obliquely through the root is almost as accurate as analyzing a quarter of the root and this method leaves the root uninjured for planting. Having selected a number of roots in the field, the crowns being preserved uninjured, they should be numbered and sampled or "cored" by means

FIG. 59.—*Lobberich Agricultural carrot. Purely a stock carrot. A vigorous grower. It permits of early cultivation and is adapted to a wide range of soils. It is somewhat tardy in growth when young.*

of a cheese trier if there are but a few; if numerous, some mechanical appliance may be devised; carefully weigh the core at once on a chemical balance, record the weight and number the core to correspond with the number on the beet. The cores may be placed in small porcelain dishes whose weights are known, and weighed in these, the labels being on the dishes. The core is left in its dish and dried; a double-jacketed, hot-water oven being advised for this purpose. When all water is expelled, which may be known by the weight remaining constant if weighed at intervals of several hours, the weight of the residue is determined, and when substracted from the total gives the loss of water. From the data, the percentage of water and dry matter is determined. If the percentage is high enough the root may be saved. Immediately after coring, the hole may be filled with cotton batting which has been dipped in a solution of formalin, thus preventing infection by disease. For this purpose, charcoal and clay are also used by European breeders. All roots should be kept cool while the test is being made and those which are selected for "mothers" should be stored in sand in a cool root cellar. Such stock is valuable, and must be well cared for.

FIG. 60.—*Orange Giant carrot. A good yielder and of good shape. Best adapted to light soils. Wires six inches apart.*

Some seed growers aim to test their roots twice, viz., as soon as harvested in order to eliminate all those low in sugar content, and then retest the remainder in spring to get rid of those which were wasteful of their nutrients in storage. Others test only in spring. The ability to store the roots will partly decide the method to adopt. In the case of mangels which are not to be used as feed before Christmas, it is essential that good storage quality be secured; hence the spring coring is the more important one; it must be compared with the results of the fall coring.

The half-sugar mangel is said to be the result of a cross between a sugar-beet and a mangel. It is an attempt to secure a mangel with a

higher dry matter content and yet retain the heavy yielding power. Unfortunately, several of those who have thus crossed these plants have not had a proper means of measuring the dry matter content, but have selected for external characters only, with the result that many of the varieties of half-sugar mangels are no richer in dry matter than common mangels, and some are inferior.

General observation supported by some experiments have shown that beets that grow deep in the soil contain, on the average, a somewhat higher percentage of dry matter than others. Thus, in the case of mangels the globe varieties with 80 per cent. of their root above ground will contain on an average 7 to 10 per cent. dry matter. The tankard varieties with 60 to 70 per cent. of the root above ground contain 8 to 11 per cent. dry matter. The long varieties with 35 to 50 per cent. of the root above ground contain 9 to 14 per cent. dry matter. Of sugar-beets, those growing with all of the root below ground are, on the average, higher in dry matter content than those with 30 to 40 per cent. of the root above ground. This general statement cannot, however, be used in regard to individuals; for it is possible to secure a globe or a tankard-shaped mangel with 20 per cent. of dry matter, so that in selection of "mother roots," shape cannot be used as a basis for selection. Furthermore, it has been observed that heavy individuals within a variety will run lower in dry matter than those of lighter weight. At the same time it has not yet been determined whether a large crop of heavy mangels will yield more dry matter than a smaller crop of light mangels. We do not yet know what is the ideal weight of an individual.

FIG. 61.—*Hollow Crown parsnip. In one test this variety yielded eight tons fresh substance, one and six-tenth tons dry matter per acre. Seed must be fresh. Grows slowly while small.*

Points to consider in selecting a "mother" mangel:

1. The yield of dry matter. This involves consideration of two factors:

(a) Size of the root, which should not be less than two lbs.
(b) The percentage of dry matter, which should be, for the present, as near 20 per cent. as possible.

2. Good keeping quality. That is, the root should not lose a large proportion of its nutrients in storage and it should retain its fresh and crisp appearance for six months after harvesting.

3. Form and shape.
(a) The crown should be single, since multiple crowns indicate coarseness and these latter generally prosper at the expense of food already stored in the root.
(b) A minimum neck. The neck is the least desirable part of the root.
(c) The dimples should not be too deep, and should be well supplied with fine rootlets which readily break off when the root is harvested.
(d) The tap root should be single, free from forking and from rootlets. The latter should be confined to the dimples.
(e) The shape may be anything that is desired or which can be most readily secured, but, for a variety to be classed as of particular shape, at least 60 per cent. of the roots should conform to that shape.

4. The roots should be free from disease.

In Europe, from sugar-beets, an average of at least a half pound of seed per plant is expected; one pound is often secured from individual plants. In the United States the general average yield of seed per plant is below that of Europe.

Mother beets should be planted on well prepared and rich land, as early as possible in spring. The land should be fall-plowed and fitted as for an ordinary crop of mangels. The roots are planted 3½ or 4 feet apart each way and the land kept clean by cultivation, or else mulched with manure. When the bulk of the seeds are ripe the crop is harvested, usually by cutting the stalks by hand, as with a corn knife. If the quantity is smaller, it is easier to tie the stalks into bundles and hang them in the barn to dry, giving plenty of ventilation. Larger areas would have to be shocked in the field to cure and then be threshed. Small quantities are easily threshed by means of a stick on a large sheet.

In planting different varieties of mother beets, including all mangels, and sugar-beets, it is generally advised that each variety be at least several hundred yards from any other variety to prevent cross fertilization, and some European growers go two or three miles. The weight of evidence is in favor of taking such precaution. In 1903, O. Pitsch

secured natural crosses by planting Golden Tankard mangels and Kleinwanzelebener sugar-beets close together. Varieties are frequently planted close together in order that they will cross-fertilize. Darwin states that the plant is capable of self-fertilization, but evidently regarded it as being generally cross-fertilized. His recorded experiments, however, were on a very small scale, but his results showed that the cross-fertilized plants produced the more vigorous seed.

2. TURNIPS.

The turnip, like the mangel, consists of a thickened stem and root, the relative proportions of which vary in different varieties, and even between individuals of the same variety, owing to variations in the plant, the soil and the method of cultivation.

It is mostly a biennial plant grown largely for its thickened tuber, which is formed during the first year of growth and used as food for stock from late summer on. The prevalent types are the common turnip, hybrid turnip and rutabaga.

The common turnip (*Brassica Rapa*) and the Rutabaga, Swedish turnip or Swede turnip (*Brassica campestris* or *Brassica rutabaga*) are thought by some to be of distinct primary origin. At the present time the turnip and rutabaga may be distinguished by the following characteristics:

	TURNIP.	RUTABAGA.
First foliage leaves	rough	rough
Color of leaves	grass green	bluish-green, or covered with a bluish-white bloom
Later leaves produced during the first year	covered with rough, harsh hairs	smooth
Neck	absent,	present
Position of leaves	like a rosette in the center of the upper surface of the "root"	on the neck which usually shows well defined, leaf-scars
Period of growth........	usually 60 to 90 days	usually 90 to 180 days
Flowers	small, usually yellow	larger, buff yellow to pale orange
"Roots"	usually smooth on the surface and in outline	usually rough on the surface and less perfect in form and outline

	TURNIP.	RUTABAGA.
Flesh	soft, usually white to yellow, more often white	firmer, white, yellow or orange, more often yellow
Keeping quality of "roots"	generally poor, should be consumed early in the season	generally good, can be kept until spring
Dry matter content......	6 to 10 per cent.	7 to 12 per cent.
Average weight of "roots"	3 to 12 ounces	16 to 50 ounces
Size of seed	small, 2 to 3 lb. usually sown per acre	larger and darker in color, 4 to 5 lb. usually sown per acre

The second year both turnips and rutabagas send up a strong stem which bears many branches, bearing heavily of seeds. The leaves produced at this time are generally bluish-green and smooth in both cases.

Hybrid turnips are said to be the result of a cross between the common turnip and the rutabaga. They may have the characters of either parent, blended in any number of ways. Thus Garton Pioneer has all the appearance of a rutabaga and has its good keeping quality, but grows faster than the rutabaga. The Yellow Aberdeen and the Green-Top Scotch Yellow, both have yellow flesh but rough leaves, and grow comparatively rapidly.

All turnips are classified commercially according to their

1. Shape.
2. Form of the upper part of the root.
3. Color of the upper part of the root.
4. Color of the flesh.

The shape of turnips:

The shapes recognized are the long, tankard, round or globe, and flat, but roots possessing every imaginable degree of variation between any two shapes may be found. Some roots taper towards the tap root; others are fairly uniform in width. The terms smooth, forked and rough are applied in the same way as for mangels.

The long type is one in which the fleshy root is three or more times as long as broad, as seen in the cowhorn turnip. (Fig. 41.) This type generally tapers toward the tap root.

The tankard shape is one having its sides more or less parallel for a length of 1.5 to 2.5 times its thickness whence it tapers abruptly to the tap roots. Frequently, in specimens of this shape, a large proportion of the root is above ground, and the part underground tapers toward the root.

The term round or globe (Fig. 39) is applied to all roots which are nearly spherical. As a rule they tend to grow deep in the soil and are well suited to deeper soils than the tankard or flat types. They are also better protected from frost, and where early fall frosts occur this is an important consideration.

In the flat-shaped roots the width is greater than the length from the " top " to the " tail." This necessarily results in the exposure of a large proportion of the surface of the root to the air.

Shape for the upper part of the root:

Roots are sometimes spoken of as " flat-topped," or " round-topped," according to the shape of the upper part of the root and the character of the shoulders. It is desirable that the crown of the root be convex, as when concave it furnishes a lodgement for water, which is liable to encourage decay.

Color of the upper part of the root:

Roots are spoken of as white, yellow, green, bronze, purple or red-tops and greystones, according to the color of the upper part of the root, i. e., the part exposed to the light, and above ground. The term " grey-stones " is applied to roots having the upper part mottled with transverse green and purple streaks.

Color of the flesh of turnips:

The flesh is generally either white or yellow. White-fleshed varieties are generally regarded as of lower feeding value, softer and more liable to be injured by frost than the yellow-fleshed varieties. They usually make rapid growth and are useful for feeding in autumn. There are, however, white-fleshed rutabagas. The yellow-fleshed varieties of common turnips are held to be more robust, less liable to injury by frost, of slower growth, and usually of superior feeding and keeping qualities than the white-fleshed. Most of the hybrid turnips which have been introduced on account of their superior merit have yellow flesh.

The neck:

The neck in the case of rutabagas may be long, medium or short. Figs. 46–49. Since it is always cut off and wasted, it should be kept as

small as possible. If fed to cattle without pulping, there is always danger that they may bolt part of the neck, and this is a frequent cause of choking.

The crown:

The crown should be single. Multiple crowns are as objectionable in turnips as in mangels. Roots possessing such are generally coarser, more fibrous and are thought to be of lower feeding value.

Soil for turnips:

The best soils are free-working loams, rich in organic matter and in good tilth. Common turnips will thrive on the lighter loams and the rutabagas will give higher yields on the medium to heavy loams, although if well supplied with moisture and manure good crops may be grown on light friable soils. Stiff clays are unsuitable on account of the difficulty in obtaining a fine seed-bed, which is an essential, and light sandy and gravelly soils are objectionable because the yield is low. The root system of turnips is mainly near the surface, and the moisture supply at this point, in the sandy soils, is liable to fail.

Climate for turnips:

Climate is of more importance than soil. For perfect development a damp, rather dull climate seems to be best. Unless the rainfall is well distributed throughout the growing period, the plants are liable to receive a check from which they never recover.

Rotation, and preparation of land:

Turnips may be grown in place of some other intertilled crop, as between two grain crops. They can not, however, be grown too frequently upon the same land without danger. Clubroot or finger and toe (*Plasmodiophora brassicæ*) attacks all the cruciferæ which are cultivated, viz., cabbages, rutabagas, kohlrabi, turnips, mustard, as well as the weeds, wild mustard and others, and if this disease once secures a foothold it may seriously reduce the yield. Other diseases, as brown rot (*Pseudomonas campestris*) and soft rot (*Bacillus carotovorous*), are best combatted by a good rotation. Generally speaking, it will be safer to grow a crop of this nature but once in a rotation of six or eight years. The land should be limed at least once in this time and the lime should be applied shortly before the turnip crop is to be grown and not immediately after it. The lime is inimical to the parasitic plant which causes clubroot, and appears to be of benefit in other ways.

The land should be prepared by fall plowing, turning under an application of about 10 tons of manure per acre. It should be very well pre-

pared in the spring. Lime slaked until it is in a very fine powder may be applied at the rate of 1,000 pounds of quicklime (unslaked) per acre, and harrowed in, and in addition 400 to 600 pounds of acid phosphate and 50 pounds of nitrate of soda per acre. These should be well incorporated with the surface soil before sowing. Too much emphasis cannot be placed on the necessity of having the land in good tilth, and the seed-bed as fine as possible.

Seeding of turnips:

Large, plump seed produces stronger plants than small seed. From two and one-half to five pounds, average four pounds of seed per acre, are usually sown in the case of rutabagas and hybrids; and from two to four pounds, average three pounds per acre, in the case of common turnips, when the rows are 27 to 30 inches apart. Less would do if we could be sure that the flea-beetles would not kill many of the plants. The young plants come up about four days after sowing. The seed should be sown at a depth of one-half to three-fourths inch, usually the former, but in a dry season the latter may be the better. Seed can readily be sown too deep. The resuults obtained during the first two years show that sowing on May 11 was over 100 per cent. better than sowing on June 12, in the case of rutabagas and turnips. The average yields are given under "Yield," (p. 129). In the cases of the rutabagas and Garton Pioneer hybrid turnips the early sowing stimulated the production of long necks, which was a waste of energy and disadvantageous, as all necks were removed before weighing.

Thinning turnips:

The stand of a root-crop has great influence on the yield. To secure more plants per acre it has been urged to make the rows closer. This, however, eliminates the use of the horse-power machinery, necessitating hand labor and rendering the crop unprofitable. In the case of rutabagas, from 26,000 to 30,000 plants must be grown per acre and of common turnips more. Twenty-seven inch rows are better than 24 inch; 30 inch rows are easier to cultivate than 27 inch. Some of the distances advised are indicated below.

	Rutabagas, No. of plants per acre.
23 inch rows, plants 14 inches asunder	19,480
24 inch rows, plants 12 inches asunder	21,780
27 inch rows, plants 10 inches asunder	23,232
30 inch rows, plants 8 inches asunder	26,136
30 inch rows, plants 7½ inches asunder	27,878

As with mangels, it is recommended that the effort be made to secure the maximum yield per row, and the use of 30 inch rows is advised, with plants 7 to 8 inches asunder. Thin the common turnips to three or four inches asunder if the variety grown is small, but six or eight inches are necessary for most of the varieties sown for stock-feeding. Some of the advantages of wide rows are, better air circulation among the plants, which aids in checking fungous diseases, fewer rows to cultivate and to thin per acre; and a consequent saving in labor, the object being to produce roots at the least cost per bushel.

Culture of turnips:

The land must be kept free from weeds. Since the plants grow quickly, not more than three or four cultivations can be given, with intervals of seven to ten days, before the leaves meet in the rows. Frequent, shallow tillage will go a long way toward ensuring success. If the plants appear stunted at any time, they should be helped by applying about 50 pounds of nitrate of soda per acre. This should be applied when the leaves are dry, for if it comes in contact with them when wet and dissolves it will burn them. The land should be cultivated as soon as possible after the application is made. The diseases which come to vigorous growing roots are few, and little provision, other than a good rotation and good methods of tillage, is made toward warding off attacks.

Yield of common turnips:

Frequently from four to twenty tons are obtained per acre. During 1904, the yield was at the rate of from 4.3 to 7.5 tons per acre, but the varieties grown were suitable only for trucking. During 1905, yields of 20 to 25 tons per acre were secured from such varieties as the Improved Green Globe and Carter Mammoth or Bullock turnip. In 1906 the largest yield was from White Egg.

Yield of hybrid turnips:

During two years (1904–05) the average yield from five varieties on 22 plats sown on May 11 was at the rate of 23 tons per acre, while those sown June 12 yielded nearly 14 tons per acre. During 1904, the yields obtained from the Yellow Aberdeen and Green Top Scotch Yellow turnips were reduced considerably by an attack of soft rot. The bacillus causing the trouble were identified by Mr. Harding of New York (Geneva) Experiment Station as *Bacillus carotovorus,* Jones, which has done considerable damage in other places. Garton Pioneer was not attacked and the average yield for the two years was at the rate of nearly

28 tons per acre from five plats sown May 11 and at the rate of 15 tons per acre from the plats sown June 12.

Yield of rutabagas:

The average yield per acre for the years 1904-5, from 14 plats and with eight varieties sown May 11, was at the rate of 21 tons, while those sown June 12 yielded at the rate of 12 tons.

Harvesting and storing turnips:

Common turnips are pulled as soon as they are large enough and are often used as fall feed for sheep, pigs, young stock or steers and in some cases for cows. Hybrid turnips are then consumed, although some of these may be stored, Garton Pioneer being a good variety for this purpose. Rutabagas are usually stored after mangels, but before serious frost occurs. They may be stored in root cellars or in pits, the former being the more convenient. The roots should not be frozen in storage and the cellar should be ventilated to ensure good keeping.

Uses of turnips:

The roots may be fed whole to pigs, and in some parts are used with bran or a little grain as the main food for wintering brood sows. For sheep, the roots may be fed whole or cut in finger pieces, sliced or pulped. It sometimes takes time for sheep to become accustomed to eating them. For cattle of any kind, it is safer to cut the roots as choking frequently occurs from bolting large-sized pieces.

Improvement of turnips:

This subject has thus far received little attention. There is some European literature on the subject and thus far all attempts at improvement have been merely the selection of roots by external characteristics. That a rational basis will soon be generally adopted is unquestioned and that improvement of the dry matter content will be made is to be expected.

3. KOHLRABI.

Kohlrabi (*Brassica caulorapa*) has been developed for its thickened stem, instead of for its leaves. Although not a root in the botanical sense, kohlrabi may be discussed with root-crops when stock-feeding questions are under consideration. It can be grown wherever rutabagas are grown, and will thrive if treated as described for the latter crop. In the middle west where rutabagas have a tendency to run to necks and

form little root, this crop is a very good substitute. So far as now known, in New York the yields of the two crops are about the same, but both yielded less than mangels on the Experiment Station grounds. In addition to being quite a free growing crop it has the following advantages over rutabagas:

1. It is not so subject to clubroot or finger-and-toe (*Plasmidiophora brassicæ*), and some other diseases.

2. It withstands drought better.

3. It can be grown on heavier soil, as clays, and does admirably on muck land.

4. It stands well out of the ground, and can be readily pastured by sheep, if desired.

5. It has not been known to cause taint of milk when fed to dairy cows.

6. It is rather better than the rutabaga in withstanding frost.

7. It may be grown where the climate is too warm for the best development of the rutabaga.

8. The leaves are as valuable as the stem.

Its disadvantages are:

The seed is more expensive than that of the rutabagas, due largely to the very small demand that exists for it; and as a consequence some of the seed sold is old and worthless.

Among well-known varieties are the White and Purple Vienna, Figs. 53–54, Short-Top White, Goliath, Carter Model.

4. Carrots.

Like the mangel and turnip, this root is made up of thickened stem and root, the proportions of which vary in different varieties. Different varieties also vary in the amount of the root which is above ground.

A section of carrot shows a well defined outer layer, which may be of a red or scarlet color in red varieties, and an inner layer or core frequently of a different color generally, yellow or dull white. The proportion existing between these two layers is variable. The outer layer is esteemed to be of higher feeding value than the pith; hence in selection the aim should be to take those containing the smallest percentage of core.

Soils for carrots:

Carrots require a deep, well pulverized, sandy loam, free from weeds. The stump-rooted or half-long types should be grown on the shallow

soils. The long types may be grown on the deep soils. The soil should be well fitted, as described for mangels. It is preferable that the manure be applied to the previous crop or else be well rotted before being plowed under. One important reason for this is that carrots being slow in germination and growth permit weeds to grow apace. Fresh manure introduces many weeds, and rotted manure is less liable to have so many. Fertilizers may be applied, especially in the earlier stages, to stimulate rapid growth.

Seeding of carrots:

What is known commercially as carrot seed is in reality a fruit. The spines on the fruits cause them to cling together and give trouble in sowing. For some time most firms have been selling seed from which these spines have been removed, thus facilitating the passage of the seeds from the drill. In the walls of the seed are small cavities which contain an oil. This oil gives the ripe fresh seed a characteristic odor, and is readily noticed if seeds are rubbed together in the hand. Carrot seed germinates slowly. Various means have been tried to hasten germination. A common one is to soak the seed in wet sand for several days before sowing, or merely dampen it and let the seed stand in a pile for seven or eight days until it shows signs of germination. The seed is then rubbed in dry sand to dry it before sowing. This is not considered practicable in all cases. Six to seven pounds of seed should be sown per acre, although if the seed is of good germination power four or five pounds will be ample.

During 1905, a careful examination was made of the different samples of seed sown and it was found that the number of seeds in a pound was fairly uniform, varying between 410,000 and 460,000. It was also found that the viability of these samples varied from 15 to 83 per cent. and that the average was 46 per cent. With the lowest of these figures it is evident that to secure one pound of seed which would grow, it was necessary to purchase six pounds, and to ensure a stand it was necessary to sow about eight pounds of seed per acre.

The seed is frequently sown in narrow rows 18 to 24 inches and thinned to six inches asunder. For field purposes it is suggested that the rows be about 30 inches and the plants left about 3 inches asunder in the rows, this would give about 55,000 to 60,000 plants per acre.

Classification and varieties:

Carrots may be classified according to their shape, as follows:

- 1. Not cylindrical
  - Taper-pointed
    - Long; as Long Orange; White Belgian, Long Red, etc.
    - Half-long; as Danvers Half-long, Carter 100-Ton, etc.
    - Short
  - Stump-rooted or Premorse
    - Long
    - Half-long; as Early Horn, Lobberich Agricultural
    - Short, as Early Frame
- 2. Cylindrical
  - Taper-pointed
    - Long; as Altringham, Long Red, and Japanese varieties
  - Stump-rooted or Premorse
    - Long; as Vilmorin Coreless Long Red

Long means length more than four times the greatest diameter.

Half-long means length more than twice but less than four times the greatest diameter.

Short means length less than twice the greatest diameter.

The not cylindrical taper-pointed are usually called "taper-pointed" and, as the name indicates, they taper gradually and comparatively uniformly from near the crown to the tap root.

The not cylindrical stump-rooted are usually called "stump-rooted" and taper somewhat from the crown downward, but stop abruptly and the tap root arises from a comparatively flat surface.

The cylindrical shape are round like a roller for at least two-thirds of their length and then taper, either gradually as in the case of a taper-pointed carrot, or else for a short space only and then have a stump root.

The varieties may again be classified according to the color of the skin as Red, Orange, Yellow or White; or according to the color of the flesh, to which the adjectives apply.

The taper-pointed varieties include many of the varieties grown for stock feeding, among which may be mentioned, Long Orange, Orange Giant, Wiltshire Giant White, Yellow Belgian, all of which are long varieties, and adapted for deep, friable soils, some of which have 25 per cent. of the root above ground. Among half-longs adapted for heavier and shallow soils are Carter 100-Ton, White Vosges, Danver Half-Long and other half-long varieties.

Some varieties which are taper-pointed and which have appeared not to fit very well into either of these classes have been called inter-

mediate; of such are the carrots grown for human consumption, James Scarlet Intermediate, Intermediate, and many others.

Among stump-rooted varieties some of the half-longs are excellent as table carrots, viz., such varieties as the Early Horn and the many varieties which have been developed from it. The short stump-rooted varieties are used largely for forcing and embrace some of the best table carrots as Early Frame, which has many synonyms.

The Altringham and the Japanese varieties are the representatives of the cylindrical and taper-pointed carrots, the Altringham being the only one of this class in general cultivation here. It is suited to deep friable soils, and is unsuited to heavy soils, where it is very difficult to harvest because it is so long and slender. Vilmorin Coreless Long Red is grown for human consumption and not as stock feed.

Cultivation of carrots:

The plants must be kept clean and thinned as soon as they are large enough to handle. It is essential that they be kept growing all the time and for this reason, light top dressings of fertilizers, as nitrate of soda and acid phosphate, may be made at intervals, during the first two months of growth. These fertilizers should be applied near the plants and cultivated in, but should not come in contact with them.

Harvesting:

Carrots are usually harvested before severe frost sets in and stored in root cellars, as other roots. During the past three years the yields varied from 7 to 25 tons per acre. Yields much higher than those obtained in the past three years are frequently reported. The leaves or tops of carrots are highly esteemed for stock-feeding, as well as the roots, and appear to be of higher value than the leaves of mangels or rutabagas. The yield of tops during two years was about four tons per acre.

Feeding value of carrots:

Carrots are esteemed for all classes of stock. They are particularly valuable for horses. The following experiment conducted by Professor Lazenby in 1879, is taken from the Cornell University Report for that year: "We have fed our work-team liberally with carrots the past season and find the crop to be one of great value for feeding horses. One bushel of carrots and one bushel of oats fed in alternate meals, were of equal value to two bushels of oats alone, while they can be grown at much less expense. Horses, like human beings, require a variety of food and thrive best upon a ration that involves a change of diet. Succulent food, in part, will always prove beneficial, and this is best afforded by carrots."

SUMMARY.

This bulletin deals with the culture of those types and varieties of roots most suitable for stock-feeding under New York conditions.

The seeds of the root-crops here considered are small and consequently are not capable of overcoming adverse soil conditions. A mellow, well fitted seed-bed with an abundant supply of moisture, but not wet, is essential. The land should be plowed deep in order to give the long-growing roots a chance to expand in the soil. Moreover, deep plowing insures a more uniform supply of moisture in the growing season. After the clods are subdued, the last fitting should be made with a light straight-disc harrow or planker in order to put the surface in garden-like condition. (See Figs. 32–34.)

Lime is almost always advantageous on soils planted to roots, especially for those of the best type. Lime modifies the soil texture and corrects possible acidity. The quantity applied should be in the neighborhood of 2,000 pounds per acre. It should be reduced to a fine powder, either by slaking or by pulverizing and worked in at the last fitting.

The germination power of many of the seeds on the market is very low; thus it is important that all seeds should be tested before planting. The germination power of the beet type of root-crop seeds varied from 73 to 185 per cent., and that of the other root-crops varied from 15 per cent. in carrots to 96 per cent. in a variety of kohlrabi. This factor of low vitality is often responsible for poor stands and poor yields. Moreover, seeds of low vitality may increase the cost of good seed greatly; in the case of the carrot above mentioned, it was nearly seven times the original cost.

The plants should be thinned before the tops become crowded, otherwise their growth will be spindling and the root system will not develop properly. If their development is checked at this time, the injury will be permanent.

A marked increase in yield of root-crops has been secured by rotation with other crops. In 1904 there was a gain of 24 tons of fresh substance with 3 tons of dry matter per acre in favor of the rotation. Rotation has been found to be a very efficient means of restricting the spread of fungous and bacterial diseases, especially leaf-spot in mangels and sugar-beets, and club-root, brown-rot and soft-rot in the cruciferous crops (as turnips and kohlrabi).

The dry matter content of the mangel has not been increased very much. Indeed, it is about the same as it was 50 years ago. The dry matter content of sugar-beets, however, and especially the sugar, has been increased nearly 50 per cent. within the last 50 years. This fact indicates that there are possibilities for the improvement of mangels and other

types of root-crops. The feeding value of roots is generally conceded to be intimately associated with or dependent on their dry matter content. The question of their improvement in this respect, therefore, is of much importance.

Early sowing is essential to a high yield of both green and dry substance. Corn and root-crops may be planted at about the same season, although, if rush of work prevents, the rutabagas and turnips may be planted a little later without much detriment to the crop. Early planting insures a long growing season and also takes advantage of those factors of the season, such as moisture and temperature, that favor root development. On the other hand, early planting increases the amount of cultivation to kill weeds.

When moisture and temperature conditions are optimum, shallow planting is to be recommended. Seeds of the beet type may be sown three-fourths to one inch deep; all others between one-fourth and one-half inch deep.

Cultivation should begin as soon as the rows can be followed. Cost is one of the most important factors in the economy of root-crop production; and labor in thinning and cultivating is one of the most important elements of this cost. Therefore, it should not be so much the object to produce high yield per unit of area as to produce a maximum yield per row. Wide rows, permitting the use of machinery and improved culture methods, are means to this end. If the stand is good, a weeder may be used for the first cultivation, driving across the rows. Shields should be used on the cultivators to prevent the soil being thrown against the young plants.

Root-crop plants do not grow into prominence quickly; therefore, it may be advisable to plant some other seed along with the root-crop, the seedlings of which are quickly discernible, in order to show the location and direction of the rows. Buckwheat is suggested for this purpose, in quantities of about one-tenth to one-fifteenth the volume of the crop seed. These seedlings may be easily removed at the time of thinning.

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CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Horticulture

SPRAY CALENDAR

Department of Horticulture

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

SPRAYING AS AN ORCHARD PRACTICE.

In the preparation of this calendar the most important points regarding sprays have been selected and arranged in such manner that the grower can see at a glance what to apply and when to apply it. The more important insects and fungous enemies are also mentioned, so that a fairly clear understanding of the work can be obtained by examining the tables. When making the applications advised, other enemies than those mentioned are also kept under control, for only the most serious ones can be named in so brief an outline. The directions have been carefully compiled from the latest results of leading investigators.

In this calendar it will be seen that some applications are in parentheses: these are the ones that are *least important*. The number of applications given in each case has particular reference to localities in which fungous and insect enemies are most abundant. If the crops are free from attack when certain applications are advised, it may be unnecessary to make them at these times but prevention in the case of fungous diseases should be the watchword. It should be remembered that in all cases success is dependent on the exercise of proper judgment in making applications. Plant diseases are rarely cured, but they can frequently be prevented. Know the enemy to be destroyed and the remedies that are most effective; then apply at the proper season. *Be prompt, thorough and persistent.* Knowledge and good judgment are more necessary to success than any definite rules. Spraying is an insurance.

Spraying is no longer an experiment, but as much an accepted practice, as tillage, and pruning and fertilizing. It may not be necessary to spray every year, but the farmer should be prepared to spray each year.

See that pumps and rigs are in working order before plowing time comes. Order your materials. Pattern after the bugs: be ready.

There is no one best pump or nozzle. There are best devices for particular kinds of work, depending on the size of plants to be sprayed, the kind of spray to be used, the extent of the operations. Get a good pump, one that work easily and smoothly and is strong enough to make a fine spray when two lines of hose and four nozzles are used, if it is designed for field work; it is economy in the end. Look over the agricultural papers for advertisements of spraying outfits and write for circulars. Power pumps are becoming more popular each year.

When Bordeaux mixture is used on fruit trees it will nearly always pay to add an arsenical poison.

The advice given in this Bulletin is intended to be suggestive merely. In so brief a space it is impossible to go into details. The person who

wants fuller information, should consult bulletins of this and other stations on the special subjects.

SPRAY INJURY.

Spraying with Bordeaux mixture made after the most approved manner, is sometimes followed by injury to the foliage. This shows itself by yellow and brown spots on the foliage. In severe cases, the leaves fall and retard or prevent the ripening of the fruit. This injury is most pronounced during rainy seasons. It appears to be worse in some orchards than others. When injury occurs with more or less regularity, though the Bordeaux mixture has been prepared with due care, the orchardist is advised to use it with an arsenical poison before the leaf buds burst only, but with great thoroughness. He is advised to use an arsenite alone soon after the blossoms fall and again at the usual time for the third spraying. Arsenate of lead, arsenite of lime or soda, or Paris green, may be used for these later applications. In following this method, the grower depends upon the first application to restrain the fungi, and the later sprayings to suppress the insect pests. These suggestions are only for those who, after the most careful trial, experience spray injury which, however, is rarely so severe as to do more harm than the spray does good.

SPRAY CALENDAR.

Apple. **Scab.** (1. Copper sulfate solution before buds break); 2. Bordeaux mixture when leaf buds are open, but before flower buds expand; 3. repeat 2 as soon as blossoms have fallen; 4. Bordeaux mixture 10 to 14 days after the third; (5, 6, repeat 4 at intervals of about two weeks). **Pink rot.** As for scab. (See Bulletin 206.) See Bulletin 84 and 226. **Blight Canker.** Keep body and main branches free from suckers. Cut out badly diseased bark in summer and fall and dress with corrosive sublimate, 1 part in 1000 parts water, then use paint or thick Bordeaux; when spraying for scab, spray trunk and branches. See Bulletin 236. **Canker-worm.** When first caterpillars appear apply Paris green, arsenite of lime or arsenate of lead very thoroughly; 2. repeat 1 after 4 to 10 days; (3, 4, repeat every 10 days if necessary). See Bulletin 101. **Bud-moth.** 1. As soon as leaf tips appear in buds, Paris green or other arsenical spray; 2. repeat 1 before the blossom buds open;(3. repeat 2 when blossoms have fallen). See Bulletin 107. **Codling-moth.** 1. Arsenical spray immediately after blossoms have fallen; 2. repeat 1, 7 to 10 days later. Use burlap bands on trunks, killing all insects under them every ten days from July 1st to August 15th, and once later before winter. Arsenicals may be added to the Bordeaux mixture and the two applied together with excellent effect. See Bulletin 142. **Case-bearers.** As for *Bud-moth.* See Bulletins 93 and 124. **Apple-maggot.** Keep windfalls picked up and destroyed or fed out. **New York Apple Canker.** 1. Remove dead limbs. 2. Spray thoroughly, soaking diseased parts, Bordeaux. See N. Y. Sta. Bulls. 163 and 185. **San Jose scale.** Summer treatment kerosene emulsion containing 20 per cent kerosene. Winter treatment: lime and sulfur wash. **Twig Blight.** 1. Cut out all diseased parts. See under pear.

Bean. **Anthracnose, pod-rust.** 1. Select clean seed. Bordeaux mixture, when first true leaf has expanded; 2, 3, etc., the same at short intervals to keep the foliage covered by the mixture.

Beet. **Leaf-spot.** 1. When four or five leaves have expanded, Bordeaux mixture; 2, 3, etc., the same every 10 to 14 days.

Cabbage and Cauliflower. **Aphis.** 1. Upon young plants, kerosene emulsion or whale oil soap , 1 lb. to 5 gals. of water when insects are first seen; 2. repeat 1 when necessary. **Black rot.** 1. Grow plants in clean soil. Soak seed in formalin, 1 lb. to 20 gals. water, for 15 minutes; guard against contamination. See N. Y. State Expt. Sta. Bulls. 232, 237. Rotate in field. **Cabbage-worm.** 1. If plants are not heading, kerosene emulsion or arsenicals; 2. Repeat 1 at intervals of 7 to 10 days; 3. If plants are heading, hellebore. **Club Root:** Use lime 75 to 150 bu. per acre, 1½ to 4 years before planting. **Root-maggot:** Pour around base of plants an emulsion of 1 lb. soap, 1 gal. boiling water, 1 pint of crude carbolic acid. Dilute this emulsion with 30 parts of water. See Bulletin 78.

Carnation. **Anthracnose or spot.** 1. At first appearance of disease, Bordeaux mixture thoroughly applied in *fine* spray; 2, 3, etc., if plants are not blooming, Bordeaux mixture; ammoniacal copper carbonate to avoid staining the flowers. Keep foliage covered with a fungicide. **Rust.** Begin with healthy cuttings, spray the plants every week during their life with copper sulfate solution, 2 lbs. copper sulfate to 45 gallons of water, or with potassium sulfide solution. **Red spider.** Syringe freely with clean water. Keep the atmosphere of the house moist. Kerosene Emulsion.

Celery. **Early blight, late blight.** 1. Apply Bordeaux mixture as soon as the plants have become established; 2. Repeat 1 every two weeks until the plants are half or two-thirds grown; 3. Apply ammoniacal copper carbonate solution every 10 to 14 days, or more often if the weather is rainy.

Cherry. **Black-knot.** See Plum. **Rot.** 1. When bud breaks, Bordeaux mixture; 2. When fruit has set, repeat 1; (3. When fruit is grown, ammoniacal copper carbonate). **Aphis.** 1. Kerosene emulsion when insects appear, 2, 3, repeat at intervals of 3 to 4 days if necessary. **Curculio.** See under *Plum*. **Leaf Blight.** 1. Just before blossoms open, Bordeaux. 2. Same after calyx falls. 3. Same 2 weeks later. **Powdery Mildew.** Spray with Bordeaux or potassium sulfide. **Slug.** 1. When insects appear, arsenicals or hellebore; 2, 3, repeat 1 in 10 to 14 days if necessary.

Chrysanthemum. **Leaf-spot.** Ammoniacal copper carbonate at intervals of 10 to 14 days, to keep the foliage protected. **Rust.** Treat as for *leaf-spot;* also wet the foliage as little as possible in watering the plants.

Cucumber, Melon and Squash. **Bacterial Wilt.** Distributed by striped cucumber beetles. Destroy these. Remove diseased leaves. **Downy mildew.** Bordeaux mixture every 10 days, or often enough to keep the foliage well covered above and below from the time the plants are very small until frost. **Striped cucumber beetle.** Keep plants thoroughly covered with Bordeaux mixture. Trap under shingles. See Bulletin 144.

Currant. **Leaf-blight.** 1. When injury first appears, before the fruit is harvested, ammoniacal copper carbonate, to avoid staining the fruit; 2. After fruit is harvested, Bordeaux mixture freely

applied; 3. Repeat 2 when necessary. **Worm.** 1. When first larvæ appear, arsenicals; 2. Repeat 1 when necessary until fruit is half grown; 3. Use hellebore if any worms remain after fruit is half grown.

Eggplant. **Leaf-spot.** As soon as plants are established in the field, Bordeaux mixture; 2, 3. Repeat 1 at intervals of 2 to 3 weeks till first fruits are one-half grown; 4. Ammoniacal copper carbonate, repeat when necessary.

Ginseng. **Alternaria Blight.** 1. Spray surface of beds thoroughly with copper sulfate solution early before plants start. 2. Spray with Bordeaux as soon as plants begin to come through soil. Add sticker, spray repeatedly while plants are coming up and expanding so as to keep all parts covered. Keep plants covered through season. Spray seed head thoroughly just after blossoms fall. See Bulletin 219.

Gooseberry. **Mildew.** 1. Before buds break, Bordeaux mixture; 2. When first leaves have expanded, potassium sulfide; 3, 4, etc., repeat 2 at intervals of 7 to 10 days, if necessary throughout the summer. **Currant-worm.** See under CURRANT.

Grape. **Anthracnose.** 1. Before buds break in spring, sulfate of copper; 2. Bordeaux mixture after 3 or 4 days to cover untreated portions. Pick and destroy diseased bunches. Burn diseased wood. **Black-rot.** Clean trellises of diseased bunches and canes. 1. As soon as first leaves are fully expanded, Bordeaux mixture. 2. After fruit has set, Bordeaux mixture; 3. Repeat 2 at intervals of 2 to 3 weeks until fruit is three-fourths grown; 4. Ammoniacal copper carbonate when fruit is nearly grown; 5, 6, etc., repeat 4 at intervals of 7 to 14 days as required. **Downy mildew, powdery mildew.** The first application recommended under **Black-rot** is of especial importance. See Bulletin 76. **Ripe-rot.** Apply very thoroughly the later applications recommended under *Black-rot.* **Steely-beetle.** 1. As buds are swelling, arsenites; 2. After 10 to 14 days, repeat 1. See Bulletin 157. **Root-worm.** Thorough cultivation in June to kill pupæ. Arsenate of lead 3 lbs. to 50 gals. water, latter part of June, to kill beetles. See Bulletins 208, 224, 235. **Leaf-hopper.** Whale-oil soap, 1 lb. in 10 gals. water applied very thoroughly to undersides of leaves about July 1st. See Bulletin 215.

Nursery Stock. **Fungous diseases.** 1. When first leaves appear, Bordeaux mixture; 2, 3, etc., repeat 1 at intervals of 10 to 14 days to keep foliage well covered. **Plant-lice.** Kerosene emulsion or whale oil soap 1 lb. to 5 gals. water, apply thoroughly. Dip tips. **San Jose scale.** Kerosene emulsion in summer. Burn, or fumigate with cyanide of potassium. Dip tops in cool lime-sulphur. See under APPLE.

Onion. **Blight.** Weak Bordeaux mixture (two-thirds strength) applied every 10 days from time plants are well up till harvest. Add sticker to Bordeaux. [Cornell Bulletin 218]. **Thrips.** Kerosene emulsion or whale oil soap, 1 lb. in 5 gals. water. **Maggot.** See root-maggot under CABBAGE.

Peach, Nectarine, Apricot. **Brown-rot.** 1. Before buds swell, copper sulfate solution; (2. Before flowers open, Bordeaux mixture); 3. When fruit has set, repeat 2; 4. Repeat after 10 to 14 days; 5. When fruit is nearly grown, ammoniacal copper carbonate; 6, 7, etc., repeat 5 at intervals of 5 to 7 days if necessary. Pick off and destroy diseased fruit in autumn. Black spot spray with dilute Bordeaux mixture. **Curl-leaf.** 1. Before buds swell (March or April) use strong Bordeaux mixture or copper sulfate solution. Lime sulfur will also control it. **San Jose scale,** see APPLE. **Curculio.** See PLUM.

Pear. **Blight.** 1. Cut out all affected branches and cankered spots in fall after leaves drop cutting a little below the point where the bark is dark or sunken. Dress with paint or thick Bordeaux. 2. Cut out whenever observed during growing season, cutting two feet below apparent injury if practicable. All branches should be cut 6 to 10 inches below point of infection; burn the parts. **Leaf-blight or fruit-spot. Leaf-spot.** 1. Before blossoms open, Bordeaux mixture; 2. After blossoms have fallen, repeat 1; 3, 4, etc., repeat 1 at intervals of 2 to 3 weeks as appears necessary. For Leaf-spot in detail see Bulletin 145. **Scab.** See under APPLE. **Leaf-blister or blister-mite.** 1. Before buds swell in spring, kerosene emulsion, diluted 5 to 7 times. **Psylla.** 1. When blossoms have fallen in spring, kerosene emulsion diluted 7 or 8 times, or whale-oil soap 1 lb. to 4 or 5 gallons of water; 2, 3, etc., at intervals of 2 to 6 days, repeat 1 until the insects are destroyed. Lime-sulfur wash or whale-oil soap 1 lb. in 1 gal. will doubtless kill many old hibernating psyllas in winter. See Bulletin 108. **Slug.** See under CHERRY. **San Jose scale, Codling moth.** See under APPLE.

Plum. **Brown-rot.** See under PEACH. **Leaf-blight.** (1. When first leaves have unfolded, Bordeaux mixture); 2. When fruit has set, Bordeaux mixture (dilute for Japanese plums.) 3, 4, etc., repeat 2 at intervals of 2 to 3 weeks, use a clear fungicide after fruit is ¾ grown. **Black-knot.** 1. During first warm days of early spring, Bordeaux mixture; 2. Repeat 1 when buds are swelling; 3. During latter part of May, repeat 1; 4. Repeat 1 during middle of June (5. Repeat 1 in July). Cut out knots. See Bulletin 81. **Curculio.** Some are successful with arsenical sprays, once before blossoming and twice after blossoms fall; arsenate of lead and arsenite of lime have been most effective; jar the trees after fruit has set, at intervals of 1 to 3 days during 2 to 5 weeks. See Bulletin 131. **Plum Scale.** 1. In autumn when leaves have fallen, kerosene emulsion, diluted 4 times; (not necessary if lime and sulfur is used; 2 and 3 in spring, before buds open repeat 1. See Bulletin 108. **San Jose scale.** See under APPLE.

Potato. **Early blight.** 1. When vines are young, Bordeaux mixture; 2 and 3, repeat 1 at intervals of 2 to 3 weeks (only partially successful). **Late blight.** 1. When plants are 6 inches high, Bordeaux mixture; 2 and 3, at intervals of 1 to 3 weeks, repeat 1. **Scab.** Soak uncut seed potatoes 1½ hours in solution of 1 ounce corrosive sublimate in 8 gallons water; or 2 hours in solution of ½ pint formalin in 15 gallons water. **Potato-beetle.** When beetles first appear, very strong arsenical spray; 2 and 3, repeat 1 when necessary. **Flea-beetle.** Bordeaux mixture and Paris green.

Quince. **Leaf-blight or fruit-spot.** (1. When blossom buds appear, Bordeaux mixture); 2. When fruit has set, repeat 1; 3, 4, etc., repeat 1 at intervals of two weeks until fruit is ¾ grown; if later treatments are necessary, ammoniacal copper carbonate. See Bulletin 80. **Blight.** As for Pear. **Curculio.** Jar or spray as for plum curculio. See Bulletin 148. **San Jose scale.** See under APPLE.

Raspberry, Blackberry, Dewberry. **Anthracnose.** 1. Before buds break, copper sulfate solution, also cut out badly infested canes; 2. When growth has commenced, Bordeaux mixture; 3, 4, etc., repeat 2 at intervals of 1 to 3 weeks, avoid staining fruit by use of clear fungicide. (Partially successful).—Badly infested plantations should be rooted out. **Orange-rust or yellows.** Remove and destroy affected plants as soon as discovered. See Bulletin 100. **Saw-.y.** 1. When first leaves have expanded, arsenites; 2. After 2 to 3 weeks repeat 1, or apply hellebore.

Rose. **Black-spot.** Spray plants once a week with ammoniacal copper carbonate. **Mildew.** Keep heating pipes painted with equal parts lime and sulfur mixed with water to form a thin paste. Spray with copper fungicides or potassium sulfide. Under glass shake flowers of sulfur over bush. **Aphis, Leaf-hopper.** Kerosene emulsion, whale-oil soap or tobacco water applied to the insects bodies at short intervals is effective. **Red spider.** Apply fine spray of water to the foliage; keep house as damp as possible without injury to plants.

Strawberry. **Leaf-blight, Mildew.** 1. When growth begins in spring, Bordeaux mixture; 2. When first fruits are setting repeat 1; 3. After fruiting, mow leaves on damp day and burn. Spray new growth and non-bearing plants with Bordeaux mixture at intervals of 1 to 3 weeks. See Bulletin 79. **Leaf-roller.** Spray thoroughly after fruit is picked with arsenate of lead.

Tomato. **Leaf-blight.** 1. While plants are in the seed bed, Bordeaux mixture, spraying under side of leaves. Pick off lower leaves as they show disease. 2. When plants are set out repeat 1. 3, etc., repeat 1 at intervals of 7 to 10 days. **Rot.** Spray as directed under *leaf-blight;* unsatisfactory in most cases. Usually better to secure many pickings by starting the plants early and giving the best culture; then if the rot comes, some pickings stand a chance of escaping. Train the vines.

FORMULAS.

Arsenate of Lead.

Arsenate of Lead	4–8 pounds
Water	100 gallons

Arsenate of Lead or "Disparene" can be applied stronger than other arsenical poisons without injury to the foliage; hence it is very useful against beetles and similar insects that are hard to poison. It also adheres to the foliage a long time. Use in strength varying from 1 to 4 lbs. to 50 gals. of water. Ready for use as soon as the paste is stirred in the water.

Paris Green.

Paris green	1 pound
Water	75–150 gallons

If this mixture is to be used upon fruit trees 1 pound of quick-lime should be added.

Repeated applications will injure most foliage, unless the lime is used. *Paris green and Bordeaux mixture can be applied together with perfect safety.* The action of neither is weakened, and the Paris green loses its caustic properties. For potato beetles, 2 to 4 lbs. to 50 gals. is often used. Use at the rate of 4 to 12 ounces of the arsenite to 50 gallons of the mixture for leaf eating insects. It is sometimes used as strong as 1 lb. to 50 gallons, on apples, but this is usually unsafe and generally unnecessary. For insects that chew.

White Arsenic.

White arsenic being cheaper and of more constant strength than Paris green, is becoming increasingly popular as an insecticide. It may be safely used with Bordeaux mixture, or separately if directions as to its preparation are carefully followed; if, however, these are neglected injury to foliage will result. It is unwise

to use white arsenic without soda or lime. The following methods of preparation will be found to be satisfactory. Methods number one and two are recommended as the least likely to cause injury.

I. *Arsenite of Soda for Bordeaux Mixture.*—To a solution of four pounds salsoda crystals in one gallon of water, add one pound of white arsenic and boil until dissolved. Add water to replace any boiled away, so that one gallon of stock solution of arsenite of soda is the result. Use one quart of this stock solution to fifty gallons of Bordeaux for fruit trees.

II. *Arsenite of Lime.*—(a) If used alone (not in connection with Bordeaux) white arsenic should be prepared thus:—To a solution of one pound of salsoda crystals in a gallon of water, add one pound of white arsenic and boil until dissolved. Then add two pounds of fresh slaked lime and boil twenty minutes. Add water to make two gallons of stock solution. Use two quarts of this stock solution to fifty gallons of water.

(b) Boil one pound of white arsenic in two gallons of water for one-half hour and use the solution while hot to slake two pounds of good, fresh, quick-lime. Add water to make two gallons of stock solution and use two quarts of this to fifty gallons of water or Bordeaux mixture.

(c) Slake two pounds of good, fresh, quick-lime and add water to make two gallons of milk of lime. Add one pound of white arsenic and boil hard for forty minutes. Add water to bring the resulting compound up to two gallons. Use two quarts of this stock solution to fifty gallons of water or Bordeaux mixture.

Other Arsenical Poisons.

Green arsenoid and Paragrene are more bulky and finer than Paris green, and when of good quality they are just as effective and require less agitation. London purple is not now used.

Bordeaux Mixture, 3-4-50.

Copper Sulfate (Blue vitriol)	3 pounds
Quick-lime (Good stone lime)	4 "
Water	50 gallons

For peaches and Japanese plums, more water (60 to 70 gallons) should be used.

Three pounds of sulfate of copper dissolved in fifty gallons of water, when applied at the proper time, will prevent the growth of fungi. However, if applied in this form, the solution will burn the foliage. Four pounds of quick-lime in three pounds of copper will neutralize the caustic action. When sulfate of copper and lime are mixed in this proportion, the compound is Bordeaux mixture.

Make up stock solutions of copper sulfate and lime, but do not mix them till ready to use, as Bordeaux mixture deteriorates after standing a few hours. Put any number of gallons of water into a barrel, and dissolve in it one pound of copper sulfate for each gallon. This is most rapidly done by suspending the copper sulfate in a gunny sack just below the surface, as the copper salt in solution sinks rapidly to the bottom. The milk of lime is prepared by slaking the quick-lime without drowning, and adding enough water to make one gallon for each pound of lime. In mixing to make Bordeaux, stir the stock solutions, and dip out one gallon for each pound of either material required, *always taking the precaution to add the full amount of water between the other two ingredients.* If the concentrated solutions are put together, a curdled lumpy mass will be formed, which will clog the nozzles and be hard to keep in suspension. If the milk of lime is lumpy or granular, it should be strained through a sieve to avoid clogging the nozzles. An

excess of lime does no harm, but an excess of copper solution brings injury to the foliage. A test for Bordeaux is made with ferrocyanide of potassium. An ounce of this substance, known to the drug trade as yellow prussiate of potash, is dissolved in a pint of water. When Bordeaux is made, it may be tested by letting three or four drops of this solution fall upon the surface. If there is too much copper salt, the ferrocyanide solution will turn brown. Lime should be added till the test liquid fails to change color. Even then it is best to add more lime to make a sure thing.

Soda-Bordeaux.

Soda (commercial lye)	2	pounds.
Copper sulfate	6	"
Lime	½ to ¾	"
Water	60	gallons.

Commercial soda lye may be used, but the mixture must be tested to insure its alkalinity. The amount of lime may in some cases be slightly diminished according to strength of the lye.

Dissolve the lye and dilute to 10 or 15 gal. and pour into the copper solution and then add lime as required. Paris green may be safely used in connection with this mixture.

"Process" Lime for Bordeaux Mixture.

The so-called "new process" or prepared limes, now offered on the market are of two classes. One consists of the quick-lime that has been ground to a powder. The other is the dry water-slaked lime, made by using only enough water to slake the quick-lime, but not enough to leave it wet. When the hard "stone" lime becomes air-slaked it is evident to the eye from the change to a loose powdery mass. Should one of these prepared limes be to any considerable degree air-slaked, its appearance would be no indication of its real condition.

A simple test for the presence of much carbonate of lime in these prepared limes, can be easily performed. A small amount of the lime—¼ teaspoonful—dropped on a little hot vinegar, will effervesce or "sizzle," if it contain the carbonate of lime, acting about the same as soda.

A sample of a new process lime analyzed at this Station, showed 30 per cent magnesia. This came from burning a dolomitic limestone, that is, one containing carbonate of magnesia with the carbonate of lime. The magnesia does not slake with water like the lime, and hence is useless in the Bordeaux mixture. There is no easy way outside a chemical laboratory of telling the presence of magnesia.

As a general rule more "process" lime is required to neutralize the copper sulfate than good stone lime.

Lime-Sulfur Wash.

Lime, 20 lbs.

Sulfur, 15 lbs.

Water sufficient to bring the boiled product up to 45 gallons.

General Directions for Preparing. The lime and sulfur must be boiled or steamed.—Mix the sulfur into a thin paste, using only enough water to break up all the lumps. Place about 15 gallons of water in a kettle, or boiling tank, or vat, if steam is employed, and heat to the boiling point. Add the sulfur paste to the boiling water and mix thoroughly. Next, add the stone lime—which should be previously weighed out and ready for use—and while the lime is slaking stir often enough to keep the lime and sulfur well mixed. In this way the entire heat of the slaking

lime combined with the heat of the boiling water will dissolve much of the sulfur. *As the sulfur goes into solution a rich brick-red color will appear.* While the lime is slaking water may have to be added to prevent boiling over. Where steam is employed it will have to be turned off until the lime is partly slaked. An excess of water, more than 15 or 20 gallons at the most, is not desirable. After the lime is slaked continue the boiling for from forty minutes to one hour, or more if necessary to get the sulfur well dissolved.

Special method by steam.—The following method is recommended by Geo. E. Fisher, former San José Scale inspector for the Province of Ontario, Canada: Steam is employed to dissolve the lump sulfur and cook the mixture. Provide yourself with eight barrels. Put in quarter the full amount of sulfur and fresh stone lime in four barrels with a proportionate amount of water. Turn the steam under a pressure of 80 to 100 lbs. (15 to 20 lbs. pressure works well) into these four barrels. When the water has boiled for a few minutes in these barrels turn off the steam. It may then be turned on to four more barrels which have been prepared in the same manner as the first set. The full amount of lime and sulfur is then added to the first set of barrels slowly enough to prevent boiling over by the heat generated by the slaking lime. When the lime is all slaked, turn on the steam again for two or three hours or till the mixture is thoroughly cooked. It is quite possible, to feed each barrel during the boiling process with a small stream of water, which will gradually fill the barrel without preventing the boiling. The mixture becomes quite thin during the boiling process, and when finished is of a deep orange color.

The mixture may also be made by boiling in iron kettles. Heat the water before adding the lime and sulfur. All the sulfur should be thoroughly reduced. Pour into the sprayer through a strainer, and apply to the trees while warm. This is to be used while the trees are dormant. This mixture has considerable value as a fungicide. It prevents curl leaf and has in some cases prevented apple and pear scab. Should be used fresh.

Ammoniacal Copper Carbonate.

Copper Carbonate	5 oz.
Ammonia or Aquafortis (26° Beaumé)	3 pints.
Water	45 gals.

Make a paste of the copper carbonate with a little water. Dilute the ammonia with 7 or 8 volumes of water. Add the paste to the diluted ammonia and stir until dissolved. Add enough water to make 45 gallons. Allow it to settle and use only the clear blue liquid. This mixture loses strength on standing. For fungous diseases late in the season.

Copper Sulfate Solution.

Copper sulfate	1 pound
Water	15-25 gallons

Dissolve the copper sulfate in the water. It is then ready for use. *This should never be applied to foliage, but must be used before the buds break.* For peaches and nectarines, use 25 gallons of water. For fungous diseases, but now largely supplanted by the Bordeaux mixture. A much weaker solution has been recommended for trees in leaf but it is rarely used.

Potassium Sulfide Solution.

Potassium sulfide (Liver of sulfur)	½—1 oz.
Water	1 gallon

This preparation loses its strength upon standing, and should therefore be made immediately before using. Particularly valuable for surface mildews.

Hellebore.

Fresh white hellebore	1 ounce
Water	3 gallons

Apply when thoroughly mixed. This poison is not so energetic as the arsenites, and may be used to within a short time before the edible portions of the plant mature. It is important to have fresh powder. For insects which chew.

Kerosene Emulsion.

Hard, soft or whale oil soap	½ pound
Boiling soft water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water, add the kerosene, and churn with a pump for 5 to 10 minutes. Dilute 4 to 10 times before applying. Use strong emulsion for all scale insects. For such insects as plant-lice, mealy-bugs, red spider, thrips, weaker preparations will prove effective. Cabbage-worms, and some other insects which have soft bodies, can also be successfully treated. It is advisable to make the emulsion shortly before it is used for insects that suck their food. For San José scale it is recommended to use 1 pound of whale oil soap and dilute in proportion of one part to six of water. Especially effective in summer to kill young and tender lice.

Tobacco Water.

This solution may be prepared by placing tobacco stems or leaves in a water-tight vessel, and then covering them with hot water. Allow to stand several hours or until color of strong coffee; dilute the liquor from 3 to 5 times for sucking insects. For aphis and soft bodied insects; not so effective as whale oil soap or kerosene emulsion.

Sticker.

Resin	2 pounds
Sal-soda (crystals)	1 pound
Water	1 gallon

Boil until of a clear brown color—1 to 1½ hours. Cook in iron kettle in the open. Useful for onions, cabbage and other plants hard to wet. Add this amount to each 50 gallons of Bordeaux. For other plants add this amount to each 100 gallons of the mixture. This mixture will prevent the Bordeaux from being washed off by the heaviest rains.

Whale-oil Soap.

Dissolve in hot water if wanted quickly. For use on dormant trees for San José scale dilute 2 pounds to 1 gallon water; for summer use on scale or aphis 1 pound to 5 to 7 gallons water.

Maxwell Dust-spray.

1 bbl. fresh lime.
25 lbs. copper sulfate.
5 " concentrated lye.
25 " powdered sulfur.
6 " Paris green.

Spread lime in large shallow box, breaking into as small lumps as possible. Dissolve the copper sulfate in six gallons boiling water; also dissolve the lye in five gallons hot water. Keep separate. Sprinkle copper sulfate solution over the lime. Follow with lye water. If the lime does not all crumble to a dust, use clear water to finish. Screen the lime through a fine sieve, rub the sulfur through the sieve into the lime, add the Paris green and thoroughly mix both with lime. Lime should crumble to powder, not granules.

Copper sulfate water must be used hot, or the copper will re-crystallize. Mixing should be done out of doors or in separate building, as lime in slaking becomes very hot.

Missouri Experiment Station Dust-Spray.

To make 70 pounds of stock powder:

4 lbs. copper sulfate.
4 " quick lime.
2½ gallons water in which to dissolve copper sulfate.
2½ " " " " slake quick-lime.
60 lbs. air slaked lime thoroughly sifted.

Dissolve the copper sulfate and slake quick-lime separately, each in 2½ gallons water. Pour at same time milk of lime and copper solution into a third vessel and stir thoroughly. Surplus water is then strained out and remaining wet material is thoroughly mixed with the 60 pounds of air-slaked lime. All lumps must be sifted out and the mixture must be perfectly dry. One pound each of sulfur and Paris green may be added.

These dust sprays are not recommended where water is readily available and where liquid spray machines can be operated satisfactorily. Their fungicidal value as demonstrated by various experiments is comparatively weak.

SOLUBLE OR MISCIBLE OILS.

These are preparations of petroleum oils, for sucking insects (scale, etc.), mixed in such a way as to emulsify readily when poured into water. They are put on the market under various names. They are ordinarily diluted 12 to 15 or more times when used. That is, one gallon of the "soluble oil" is to be mixed with twelve or fifteen gallons of water. After stirring, it is ready for use. In this respect, they are exceedingly convenient and commend themselves to the orchardist. This spray, however, costs considerably more than lime-sulfur. Some have used these materials with excellent results, others report complete failure, while others find that the results are inconstant in character. They are to be used only during the dormant period in the strengths mentioned. At present it does not appear to be safe to use them on trees in foliage. We recommend each grower to use these mixtures experimentally until their efficacy has been more definitely established.

FUMIGATION OF NURSERY STOCK.

Some General Rules.

Do not fumigate trees when they are wet. Fumigate from half to three quarters of an hour. Do not leave the gas in the house over night. A house ten feet square will answer for a nursery of one hundred acres. Find your space, figure amount of chemicals needed and post in a convenient place for reference.

Formula for 100 Cubic Feet of Space.

1 oz. Potassium Cyanide.........................98–100 per cent purity
2 ozs. (fluid) Sulphuric acid.......................66° B test
4 ozs. Water.

For a room 10 x 10 x 8 ft. ,the following charge would be required:
½ lb. Potassium Cyanide.
16 ozs. Sulphuric acid, 1 pint.
32 ozs. Water, 1 quart.

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Animal Husbandry (Poultry Husbandry)

A GASOLINE-HEATED COLONY BROODER-HOUSE

By JAMES E. RICE and ROLLA C. LAWRY

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY.

ORGANIZATION

Of the Cornell University Agricultural Experiment Station.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

A HISTORY OF THE DEVELOPMENT OF THE GASOLINE-HEATED COLONY BROODER-HOUSE DESIGNED AND USED BY THE NEW YORK STATE COLLEGE OF AGRICULTURE, WITH THE ADVANTAGES AND DISADVANTAGES OF ITS USE.

The most difficult problem in successful poultry keeping is to raise the chickens to renew the flock. The most expensive factor in rearing chickens is the labor required to handle the large number of brooders necessary where chickens are kept in small flocks.

This bulletin presents to the public a method of brooding which, it is believed, eliminates at least three-fourths of the labor required to brood chickens. The system has been thoroughly tried for the past seven years, during which time it has been improved until we feel warranted in the statement that it is a practicable, workable, economical and safe method of rearing chickens in large numbers.

I. The History.

So far as the writers know, the idea of using gasoline to heat brooders was first suggested in 1901 by Fred Graham, who was then a poultry helper in Cornell University. Mr. Graham at that time had not tried to use gasoline but told the senior writer of this bulletin that he had seen a gasoline burner which he thought could be adapted to the heating of brooders. A year or so later, after trying some experiments with gasoline, Mr. Graham gave to White & Rice, Yorktown, N. Y., permission to use the heater which he had devised. The attempt to use gasoline was a failure owing to faulty principles in the construction of the

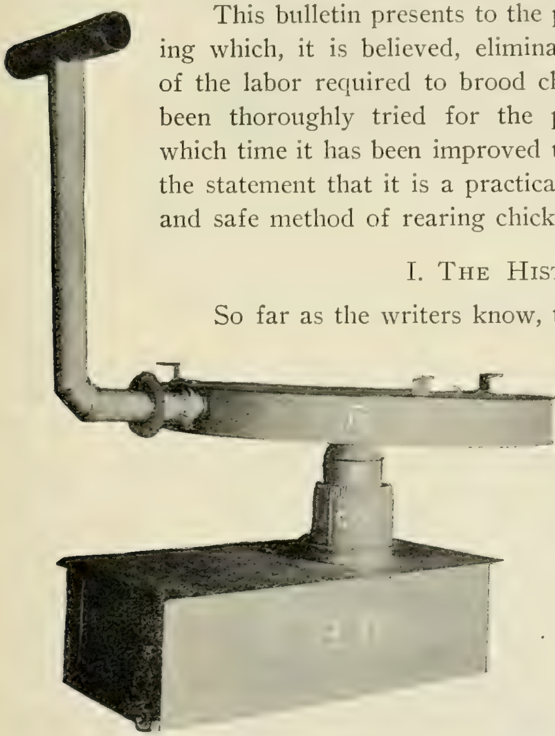


Fig. 62.—*The Gasoline heater complete as designed and used by the New York State College of Agriculture. B B, burner box. C G, chick guard. S, stem. R, radiator.*

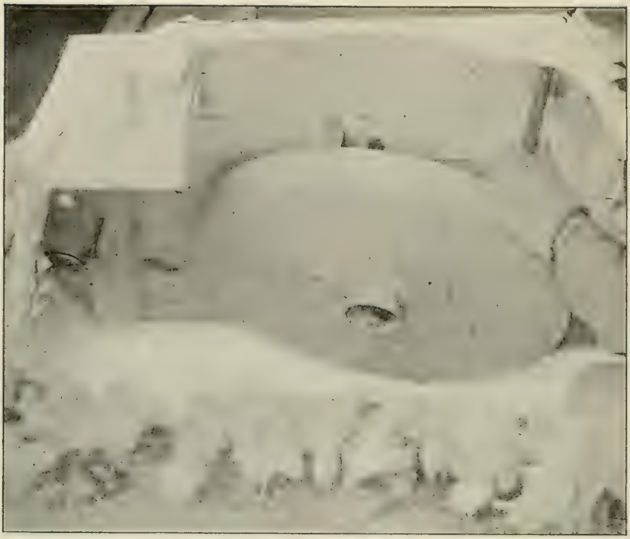


FIG. 63.—*The hover and heater drum raised.*

heater. It was not fire proof, did not supply sufficient heat, was a cumbersome hot water system, too expensive to make, and therefore, was abandoned. However, the idea of using a blue flame gasoline burning lamp without wick to trim or lamp to fill each day, was attractive. White & Rice, therefore, adapted the gasoline burner to the heating of ordinary outdoor brooders by using a heater invented by C. S. Menges of Yorktown, N. Y. The heater was the one then being used in home-made brooders, heated with kerosene lamps.

The experiment was successful in so far as it saved labor and furnished a high heat, but it was not fire proof. The penalty of the experiment was several expensive fires. It was quickly seen that heat was being wasted in the small brooders containing 50 chickens each and that much heat could be saved by building colony houses 6 x 8 feet and furnishing the same amount of heat to two flocks of 50 chickens each from the same burner and heater under a divided hover. This plan worked so satisfactorily that the partition separating the two flocks was removed for subsequent hatches as an experiment, and it was found that one flock of 100 chickens running together did as well or better than the two flocks of 50 chickens each. A very large hatch later in the season when press of work prevented the building of more colony houses, compelled the putting of 200 chickens under one enlarged hover. These chickens apparently did as well as those kept in flocks of 100. As a result of this experience all of the colony houses were fitted with large hovers for 200 chickens and the outdoor brooders were entirely abandoned. By this method of rearing chickens in large flocks in colony houses heated with gasoline, from 1,700 to 2,000 chickens have been reared each year for the past five years in 13 colony houses which formerly would have required about 50 ordinary kerosene heated brooders.

Up to 1903, the Menges heaters only had been used. While they were eminently satisfactory for heating with kerosene, they were not large enough, durable enough, nor safe enough for gasoline heating, especially where chickens were to be kept in large flocks in colony houses.

When the junior partner of the firm of White & Rice became connected with the Poultry Department at Cornell University in 1903, he began immediately to try to make a heater that would meet the needs of gasoline heating. Several heaters were invented and various types of houses were used. Progress was made particularly in the matter of making a fire-proof heater by providing a galvanized burner box with a device for removing gasoline that might flow if the burner becomes extinguished, the use of a five gallon instead of a one gallon supply tank, and the placing of the tank inside instead of outside the house.

At about this point in the development of the system of heating brooder houses with gasoline (1905), the junior writer of this bulletin joined in the effort, and contributed improvements in the house and hover and a greatly improved type of heater which provided a better system of furnishing a regular supply of pure air; a heater that would supply a larger quantity of heat for the amount of gasoline consumed and one that can be more easily placed and removed from the house. (Plate I and Fig. 62.)

Dr. E. M. Santee of Cortland, N. Y., at that time a special student in Cornell University, suggested the idea of making the tank longer and suspending it horizontally as it is now used, so that it could be filled from the end, instead of placing the tank vertically to be filled through the roof, as it was then done.

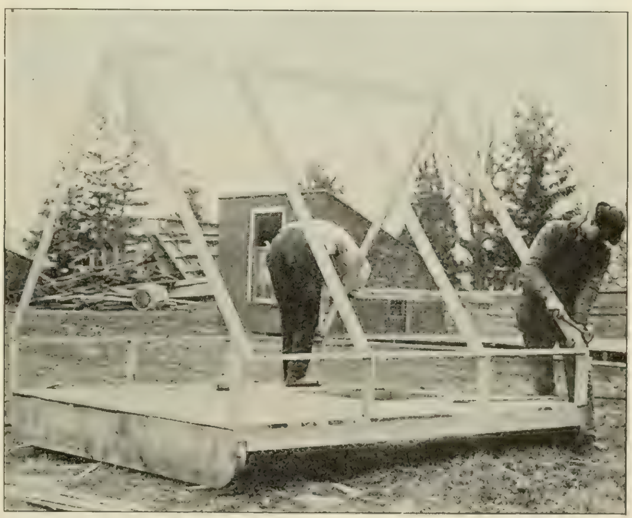


FIG. 64.—*Putting up the frame.*

Mr. C. L. Opperman of College Park, Md., then a special student in Cornell University, suggested the can for quick filling. (Plate I and Fig. 74.)

Floyd Q. White of Yorktown, N. Y., formerly a student at Cornell,

first advocated and tried the plan of placing the burner box under the house which did away with the extra raised floor then used under the hover and the steep incline made necessary when the burner box was placed above the main floor.

The "A" type house with low sides as here shown was originated in its entirety in the Poultry Department at this college, but we have recently learned that C. E. L. Hayward of Hancock, N. H., has been using for nearly 30 years an "A" house for egg production, quite similar in type.

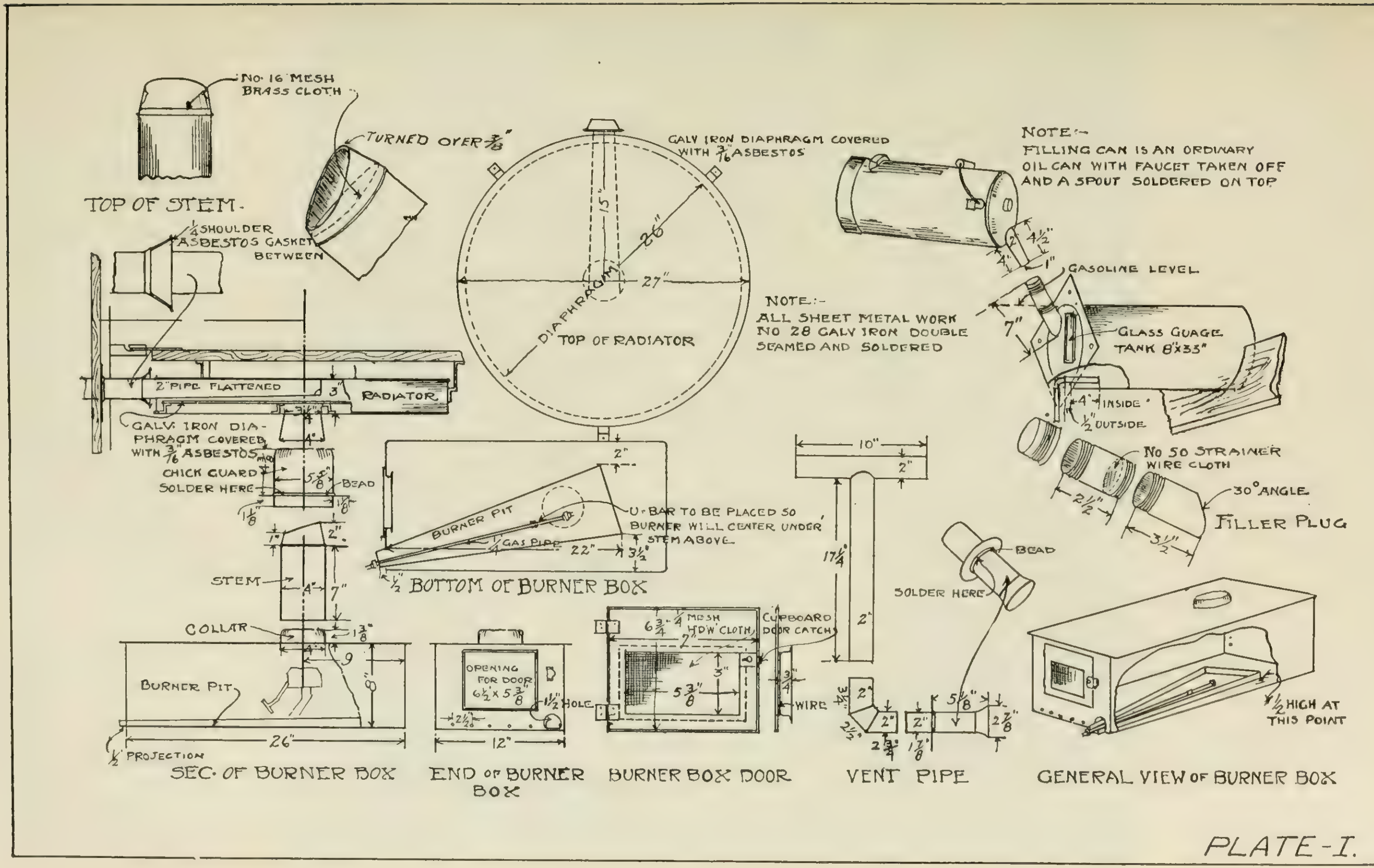
II. THE PRINCIPLES OF BROODING.

Many factors enter into the construction of a perfect brooding system. Of the many brooding devices now in use, including the one here presented, not one can claim perfection or a monopoly of all the desirable features. Each system has its advantages and its disadvantages. There are at least 18 important features which should be found in a successful system of brooding. The extent to which they are furnished in the Gasoline-Heated Colony Brooder-House, as designed and used by the New York State College of Agriculture, and the principles involved, will be discussed under separate headings as follows:

FIG. 65.—*One of the latest models.*

1. *A temperature of* 100 *degrees at all times accessible to the chickens.*

A temperature of 100 degrees is essential to successful brooding of chickens in either large or small flocks. The larger the flock the more important it is that a high temperature be maintained, because the greater is the danger of crowding. When the chickens become cold they like to go quickly to a warmer temperature than they could occupy with comfort or safety if compelled to remain there. Chickens will crowd when they become cold if sufficient heat is not supplied. It is but natural that they



No. 16 MESH BRASS CLOTH
TOP OF STEM
TURNED OVER 3/8"
1/4 SHOULDER
ASBESTOS GASKET BETWEEN
2" PIPE FLATTENED
RADIATOR
GALV. IRON DIAPHRAGM COVERED WITH 3/16" ASBESTOS
CHICK GUARD
SOLDER HERE
BEAD
STEM
COLLAR
BURNER PIT
1/2" PROJECTION
SEC. OF BURNER BOX
GALV IRON DIAPHRAGM COVERED WITH 3/16" ASBESTOS
DIAPHRAGM
TOP OF RADIATOR
U-BAR TO BE PLACED SO BURNER WILL CENTER UNDER STEM ABOVE
GAS PIPE
BOTTOM OF BURNER BOX
OPENING FOR DOOR 6 1/2 x 5 3/8
1 1/2" HOLE
END OF BURNER BOX
1/4 MESH HDW. CLOTH
CUPBOARD DOOR CATCH
WIRE
BURNER BOX DOOR
NOTE:- ALL SHEET METAL WORK NO 28 GALV IRON DOUBLE SEAMED AND SOLDERED
VENT PIPE
NOTE:- FILLING CAN IS AN ORDINARY OIL CAN WITH FAUCET TAKEN OFF AND A SPOUT SOLDERED ON TOP.
GASOLINE LEVEL
GLASS GUAGE
TANK 8"x35"
INSIDE
1/2" OUTSIDE
No 50 STRAINER WIRE CLOTH
30° ANGLE
FILLER PLUG
BEAD
SOLDER HERE
1/2 HIGH AT THIS POINT
GENERAL VIEW OF BURNER BOX

PLATE - I.

should. A chicken's body temperature is normally about 105 to 106. Therefore, a cold chicken can not be blamed for rubbing up against another chicken 105 degrees warm instead of standing alone in a temperature of 80 to 85 degrees. The more the chickens crowd the hotter the pile becomes and, therefore, the more attractive is the source of heat to the chickens on the outside. If a temperature of 100 degrees is main-

FIG. 66.—*One of the latest types. Note the cloth window in the upper part of door; also the chick exit, which is provided by opening the side window.*

tained, the chickens will spread out of their own accord. They can be trusted to remain in the temperature which is most comfortable to them, which also will be the temperature best suited to their needs. The first sense to be developed in a young chick, seems to be the sense of touch, as manifested by the sensation of warmth, which to the chick means comfort and comfort to the chick means home. The first instinct, therefore, to be awakened in the chick appears to be that of location. When

once it feels and sees the source of heat and comfort, it will almost invariably return to it.

The importance of a high temperature in a brooder cannot be over estimated. It is vitally important. Heat brought the young chick into the world and lack of heat will take it out of the world. Without warmth chickens do not sleep well. They huddle, i. e., they are compelled to stand up to avoid being trampled to death. A chicken cannot sleep standing. Without sleep a chicken does not rest. Without rest a chicken cannot grow. Sleep and rest are as important to a chicken as to a baby. A large part of the slow growth and mortality with young chickens is caused by lack of sleep, due to lack of heat.

A higher heat can be maintained with a gasoline burner than is practicable with a kerosene burner. The high, even heat of the gasoline vapor flame insures a constant temperature of 100 degrees at all times over a large area under the heater and a living temperature of from 70 to 90 degrees under the hover at its outer area. Figs. 63, 76 and 77, and Table 1, page 220.

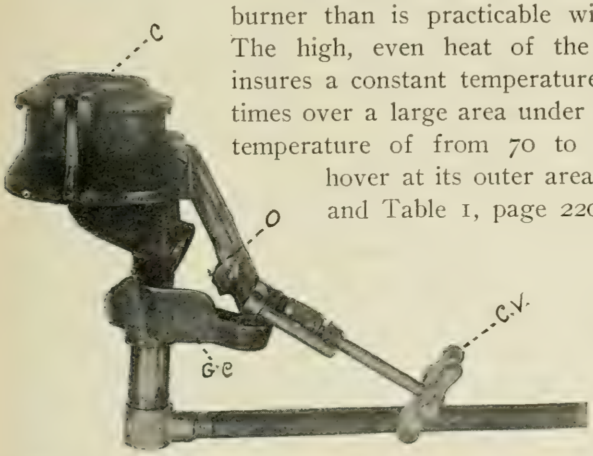
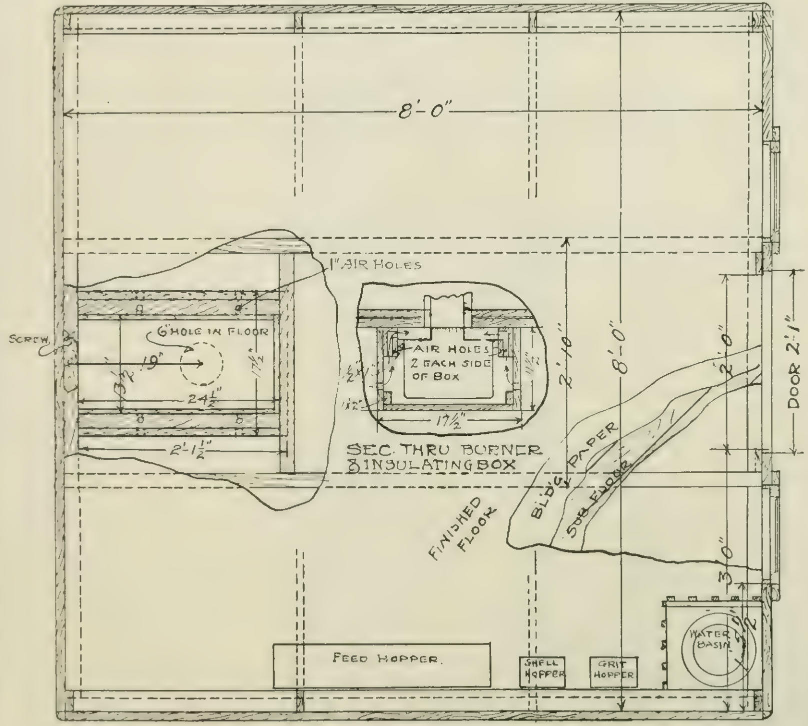


FIG. 67.—*The Dangler Furnace and Laboratory lamp burner No. 154. C V, control valve. G C, generating cup. O, small opening in valve seat. C, cone.*

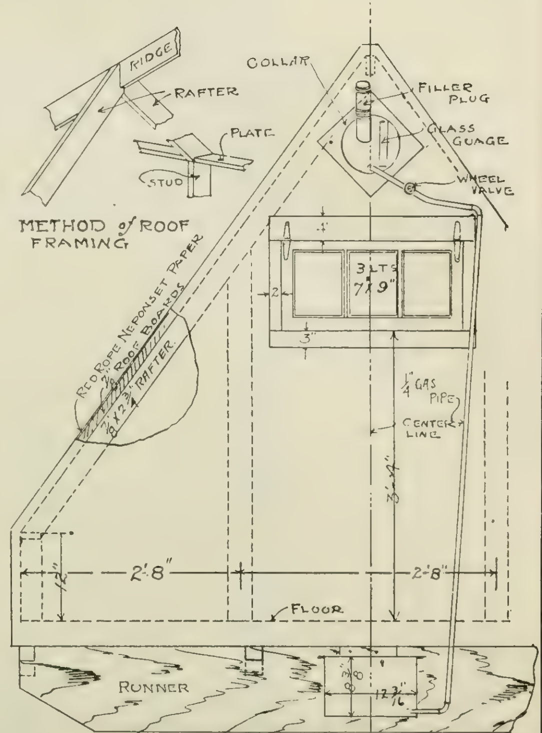
2. *An abundance of both warm and cool pure air without injurious drafts.*

Pure air is even of more vital importance to poultry than it is to other domestic animals because of the warmer temperature of the fowl's body, which is normally 105 to 106 degrees. This high body temperature is maintained by combustion of pure air with the food nutrients contained in the blood. Without pure air perfect combustion is impossible. Without perfect combustion the chick cannot be warmed from within the body and therefore, will not be comfortable nor healthy even in a warm brooder. The chick is a quick-growing, quick-breathing animal, requiring rapid digestive and assimilative changes and therefore, suffers seriously and quickly when closely confined and compelled to breathe impure air. Leg weakness is almost certain to result from close confinement and heavy feeding which usually is accompanied by a close and more or less vitiated atmosphere.

The Gasoline-Heated Colony Brooder-House provides for a continuous supply of pure air from outside the house. (Plate IV, Fig. 2.)



-FLOOR PLAN-
FIG. I



-REAR ELEVATION-
FIG. 2

PLATE-II

When the air enters the hover it is warm but not super-heated. The chick, therefore, is not kept warm by breathing hot air but is warmed by radiated heat from the drum. The air space within the house as well as under the hover, is large. The house contains 240 cu. ft. of air space, 1.2 cu. ft. per chicken. Moreover the provision for constant change of air by means of the cloth window or the opening in the front or the rear of the house, or both, as may be preferred, insures fresh air at all times. Most outdoor brooders contain about 28 cu. ft. air space which allows

FIG. 68.—*Cross section drawing of burner.*

.28 cu. ft. of air space per chick with 100 chicks a brooder, or .56 cu. ft. with 50 chicks, which necessitates rapid change of air, a condition hard to accomplish without draughts.

3. *Opportunity to get away from the heat and to exercise in cool air.*

It is not sufficient simply to supply heat and pure warm air in a brooder. It is quite as important that chickens have an opportunity to enjoy the invigorating effect of pure, cold air. Chickens that are not given this opportunity are likely to become languid and weak from the hot house treatment. The brooding system here described provides for three different areas of temperature within the house; namely, a high

temperature under the heater drum, a moderate living room temperature between the drum area and the outside edge of the hover and a cool house temperature outside the hover where the chickens have an abundance of room to exercise in the cool air. During favorable weather a fourth area of temperature is provided out of doors by a cloth fence enclosure where the chickens can get to the ground early in a sheltered, sunny spot. Fig. 69.

4. *A large extent of room for exercise.*

The chick is naturally active. It cannot continue in health under close confinement. A young, active animal kept under restraint fails to develop naturally. Opportunity to scratch and run is essential even from the very first. The larger the floor space is per chick, the easier it is to keep the brooder clean. The system here described provides 64 sq. ft. floor space which is .32 sq. ft. floor space per chick where 200 chicks are kept in a house In many of the modern outdoor brooders, there is about 20 sq. ft. floor space equal to .2 sq. ft. floor space per chick with 100 chicks or .4 sq. ft. floor space with 50 chicks in a brooder. The larger brooder gives greater liberty of action to chickens than does a smaller one having the same number of square inches floor space per chicken.

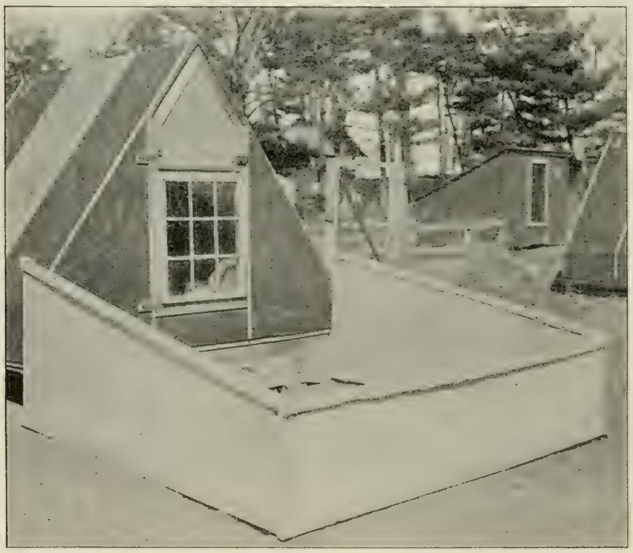


FIG. 69.—*Cloth enclosed yard for early spring use.*

5. *An abundance of sunlight in a brooder is essential.*

Sunlight gives good cheer, adds warmth, kills the germs of disease, keeps the litter dry and provides light for the chicks to hunt for food in the litter early in the morning and late in the afternoon, all of which are of great importance.

The various plans for fronts here presented, provide for a liberal supply of sunlight. Just where it is best to place windows and how large

the glass or cloth area or other openings should be, has not yet been determined satisfactorily, although many different plans have been tried. Each plan here presented has some advantage and some disadvantage over the others. The large glass window in the door furnishes a good supply of light, satisfactorily distributed and a cloth area in the door above the glass window provides a desirable method of changing the air without drafts, taking it out at the highest point, and also furnishes some light to the room (Figs. 69 and 75), but the door is expensive to make and is of weak construction. The glass window when hung at the top and swung outward, makes the house too hot in warm weather. To remove it during the summer and replace in the fall, is troublesome. It is likely to get broken when the door is left open or while doing the daily work. The small windows on either side of the solid doors places the

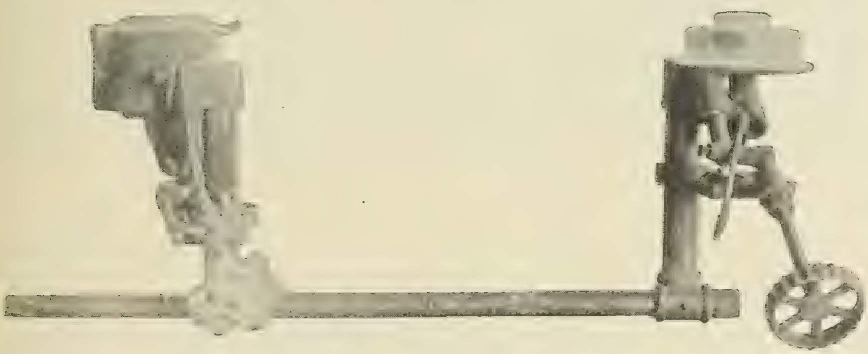
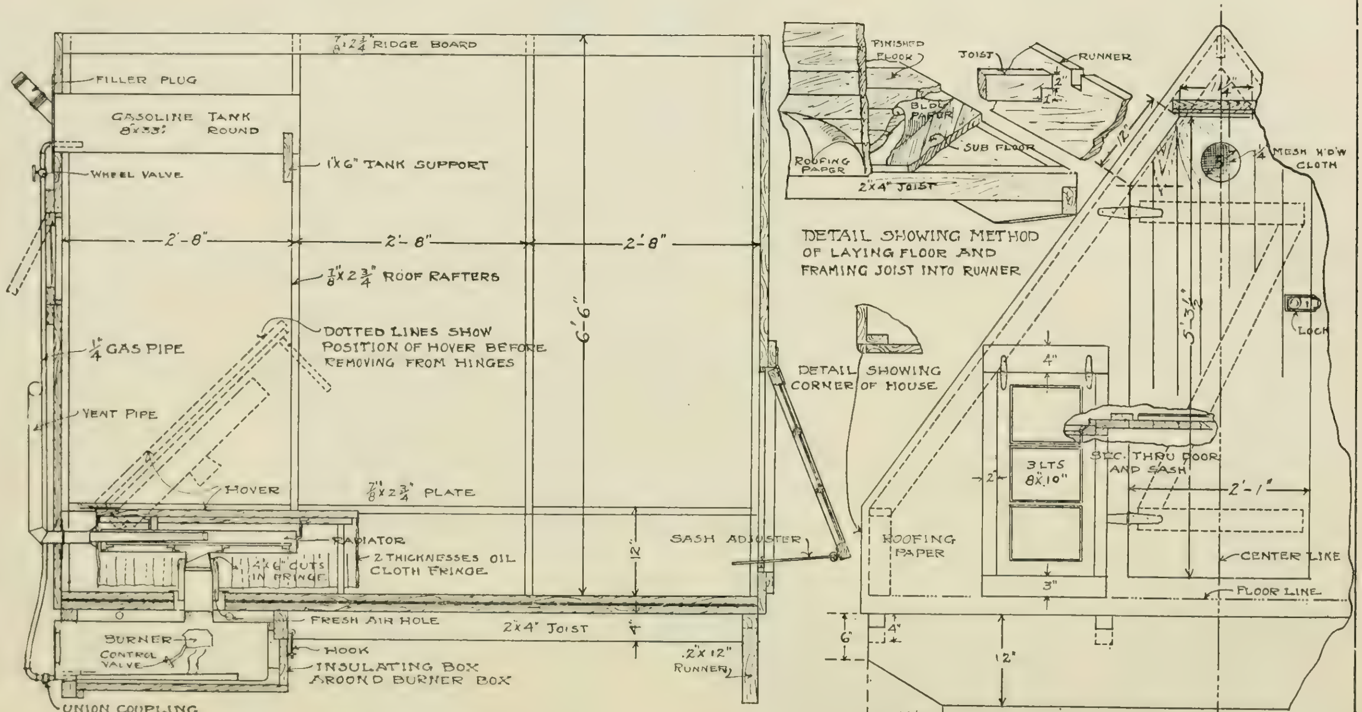


FIG. 70.—*The Dangler and the Omaha burners.*

light near the floor and provides an exit for the chickens. Figs. 65 and 66. The opening in the upper part of the door to admit light and air higher up appears to be an improvement. Fig. 66. The door is serviceable and cheap. The reader will have to depend upon his own originality to construct a front which will provide light and ventilation best suited to his conditions, basing his construction on the principle that there should be provided about one square foot glass area to each 12 square feet floor space and about the same amount of cloth area, depending upon the thinness of the material, the location, and the tightness of the house. If a small mesh wire screen is to be used instead of cloth, the opening must necessarily be much smaller in size.

A poultry wire screen should be placed inside the windows if they swing outward or outside the windows if they swing inward, to prevent the chickens escaping or marauders entering when the glass windows are open, as they should be most of the time.



-SEC. THRU HOUSE-
FIG. I

-FRONT ELEVATION OF HOUSE-
FIG. 2.

PLATE-III.

6. *Plenty of room for the attendant to work inside the house.*

The house here described furnishes sufficient head room so that the work can be done inside by the attendant during stormy or severely cold weather. This is a great advantage when compared with the type of outdoor brooder in which the cover must be raised in order to feed and water the chicks or to clean the brooder, which system also has the disadvantage of allowing a large volume of heat to escape whenever the cover is lifted and it also permits the chickens to fly out, thus causing annoyance. A house of the size and style shown makes it very convenient to do the work. The entire floor space is available, accessible and easily cleaned. The hover is against the rear wall, easily raised and fastened or removed. It is high enough at the entrance in the center of the house to enable the attendant to stand erect when walking from front

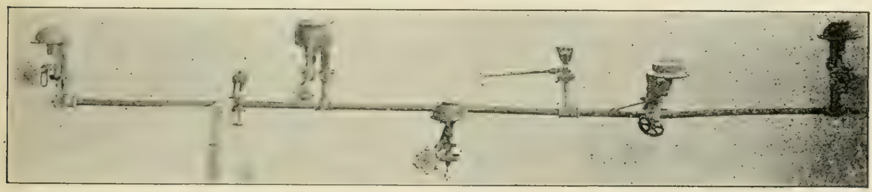


FIG. 71.—*Seven types of burners in position for testing.*

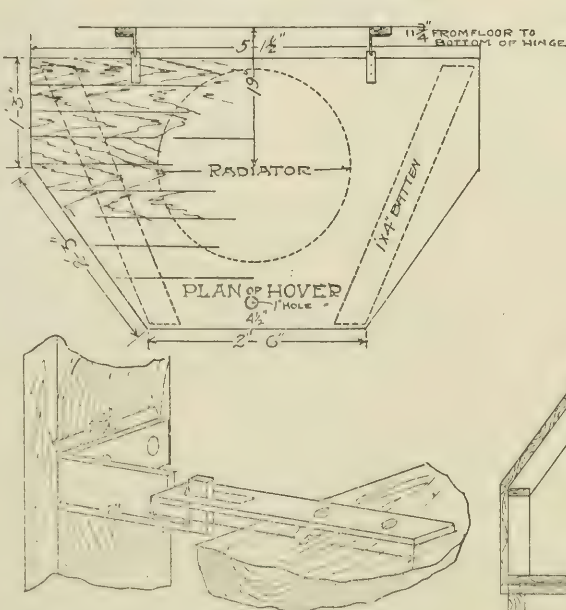
to rear and caring for the brooder, and he can reach to either side without inconvenience, in attending to the chickens on the floor.

7. *Workable all the year round.*

The Gasoline-Heated Colony Brooder-House contains 64 sq. ft. floor space. Therefore, it is large enough to accommodate from 12 to 15 fowls when not in use for rearing chickens. This enables the investment to be used the entire year, a decided advantage over any system of brooding which compels a large amount of capital to be idle except during the comparatively short brooding season.

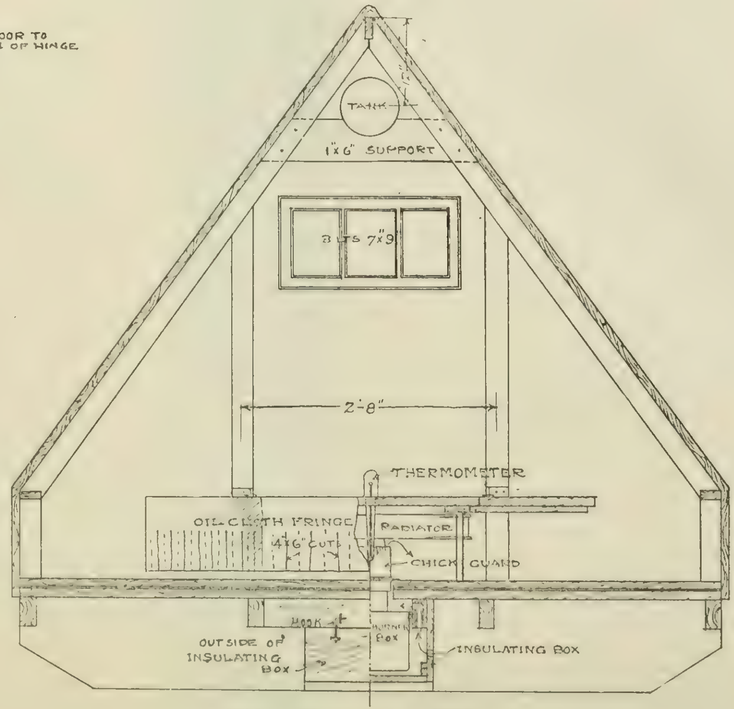
When the house is used for mature fowls, the platform is placed on slides attached to the rafters at the backside of the house from which the perches are placed. (Plates V and VI.) The nests are arranged along either side of the house, attached to the rafters. In order to prevent the litter from being scratched out of the house, all doors and window openings should be raised two or three inches above the floor.

While a house of the style here suggested is not the best for mature stock because too small and for that reason not to be recommended where the building is to be used for adult fowls only, nevertheless, it can be put to most profitable use during the larger part of the year when not used in rearing or housing the young stock.



·DETAIL OF HOVER HINGE·

FIG. I



SEC·THRU·HOUSE

FIG. 2

PLATE-IV.

This type of house also has the decided advantage of being large enough to accommodate the chickens during the entire season of growth, which makes it unnecessary to remove them to summer houses or compel them to roost in trees as they must of necessity do, where reared in the small outdoor brooders. Chickens should not be moved from one brooder to another or handled or mixed up, if it can possibly be avoided. It checks their development.

The plan here recommended presupposes that the 200 chickens will have the benefit of the grass covered yard after the first week and a large free range thereafter, which is highly essential for the best results. It also assumes that the sexes are to be separated as soon as they are recognizable and are old enough so that they do not longer need brooder heat. The exact time when the sexes can be separated and removed from the brooders, depends upon two factors; the breed and the season. The Mediterranean class feather more quickly and show sex characteristics earlier that the general purpose or larger breeds. The chickens of any breed could not be separated and removed from the brooders at as early an age for the early hatches as they could be for the later hatches when the weather is warmer. The disadvantage of moving and mixing up the cockerels from different brooders is more than offset by their fighting less and by their more rapid growth when separated from the pullets. What is quite as important, it relieves the crowding in the brooder house which would be certain to occur if all of the chickens should be allowed to run together until mature.

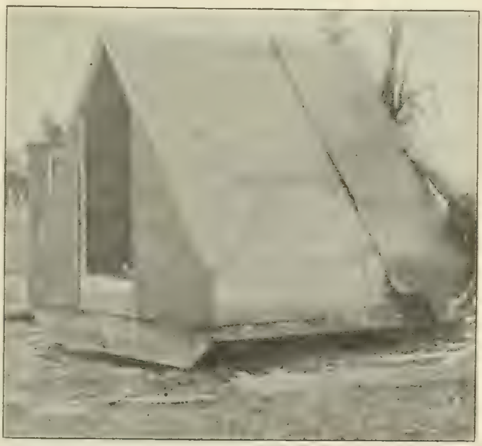


FIG. 72.—*Laying the paper roofing.*

8. *Portability.*

The house is placed on runners so that it can be moved by a team or even by hand if placed on rollers. (Plate V, Figs. 64 and 72.) A rope completely around the house, attached to the evener of the whiffletrees, holds the house steady while moving by team. It then can be taken to fresh ground easily and frequently if necessary during the season or to a new chicken park each year. This is a valuable feature in any system of brooding because it enables the flocks to get the benefit of free range. In many instances this colony house can be moved to

meadows, pastures or even corn fields where the chickens can enjoy the natural conditions for development, which are absolutely essential to strong, healthy bodies and rapid, normal growth. Very large poultry establishments must provide for rearing the chickens on new, clean sod land at frequent intervals, each year if possible, if the plant is to be permanently successful. This is particularly important where chickens are reared to maturity and are to be kept for breeding purposes.

9. *Permits double use of ground.*

The fact that the type of house here recommended stands on runners one foot high has the double advantage of furnishing desirable shade which frequently cannot be provided without considerable extra trouble and expense, and also adds 64 sq. ft. to the size of the yard area. This is an important consideration where the yard area is limited. Since it is raised one foot from the ground the house does not become a harboring place for skunks, rats and other vermin, and the floor is always dry. The height from the ground does not prove a serious handicap to the chickens which are obliged to pass up and down a rather steep incline when entering and leaving the colony house.

A narrow mesh wire fence, one and one-half feet high, staked temporarily in front of the exit door, should be provided to confine the chickens to a limited space until they are able to fly over the fence, after which the fence should be tacked to the building to prevent chickens from going under until old enough to go into the house of their own free will. After they are a few weeks old the wire may be removed to other houses and used in connection with younger broods.

FIG. 73.—*Placing the burner box.*

Where other shade is naturally provided or can easily be secured, the wire about the house may be retained and the chickens not allowed to go under the house. Occasionally some trouble is experienced by having the chickens run under during

a rain storm because it is handier to do so than to enter the house. The high runners also make the house colder in winter because more difficult to bank up to prevent the wind from blowing under the house.

10. *Economy of fuel.*

The cost for fuel is about the same for supplying heat to a given number of chickens by the gasoline system as it is where kerosene is used. The price per gallon for gasoline, however, is several cents higher than kerosene. A little less gasoline is used for one flock of 200 chickens than kerosene for heating four brooders containing 50 chickens each. In moderately cold weather it costs about seven cents per day to heat a brooder house containing 200 chickens. The larger the number of chickens, the less the cost of fuel. This is due to the warming effect of the heat radiated from the bodies of the chickens.

11. *Safety from fire is an important consideration of the gasoline system of heating.*

There is less danger from fire with gasoline than there is with kerosene when the system is properly understood, which knowledge may readily be acquired by any one who is capable of being entrusted with kerosene heated brooders. The gasoline system has the advantage of safety in the fact that only one source of fire is possible with 200 chickens, whereas, with small brooders there are four possible fires with four flocks of 50 chickens each. The great danger of fire from kerosene comes during cold weather when the flames are turned up high in order to secure enough heat to keep the chickens warm or when the wicks are not properly trimmed, or where drafts occur, which start the formation of soot, which in turn takes fire, unsoldering the lamp and other parts, thus reaching the woodwork. The blue flame of the gasoline burner provides an abundance of heat without the necessity of turning the burner too high even in very cold weather.

FIG. 74.—*Filling. A small hole should be punched in the cap of the oil can to insure an even flow of gasoline and steady flame.*

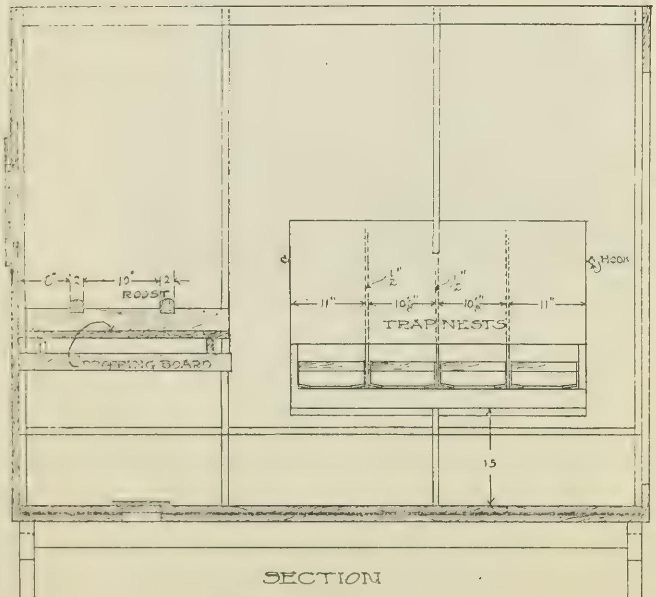


FIG. I

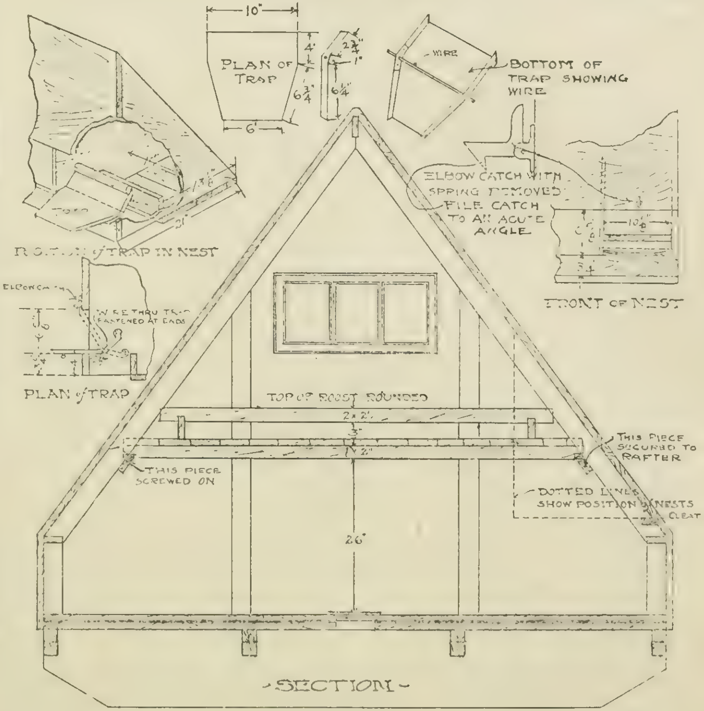


FIG. 2

PLATE-V.

The danger with the gasoline system might come from too high a flame which also might unsolder the metal work, or what is more likely to be the case, the gasoline flame might go out when run too low owing to the break which may occur in the flow of the gasoline due to air bubbles, foreign matter or the presence of water in the gasoline which settles in the burner as the gasoline evaporates. This does not often occur. The gasoline will continue to flow when for any reason, the flame is extinguished and will fill the heater space with a very explosive vapor. The attendant who through carelessness or ignorance undertakes in such case to light the burner before the vapors have escaped, may cause an explosion the instant the flame comes in contact with the vapor. Gasoline itself is not explosive. It is the vapor which

FIG. 75.—*Two types of fronts which are being tried. Too much cloth in the front makes the temperature too variable for winter use, or in exposed locations.*

is given off that causes explosions and which ignites and burns. Such a fire is difficult to extinguish because the vapor is expansive and readily rises and burns where a liquid could not go. There is also danger from fire, if the heater be so constructed that the flame can by any possibility reach the woodwork. In order to guard against this possible danger, the heater here recommended is made of galvanized iron so joined as to make unsoldering impossible. (Fig. 62.) It is made as nearly fire proof as it is possible to construct any device where a flame is used. In order to prevent explosions and to provide against danger through carelessness in case the flame should go out, the heater is so constructed that the gasoline is conducted out doors instead of leaving it to evaporate within the burner box. (Plate I.)

12. *A large, roomy hover.*

A large hover, almost the entire width of the house, with slit table oilcloth curtains to prevent a too rapid escape of heat from under the

hover, provides the chickens with a large area where they may find the different degrees of heat best suited to their needs without going into the colder air of the house proper. (Plates I, III, Fig. 63.) This hover is made with table oilcloth curtains on all sides so as to provide the largest possible amount of curtain area open to the air of the house at all

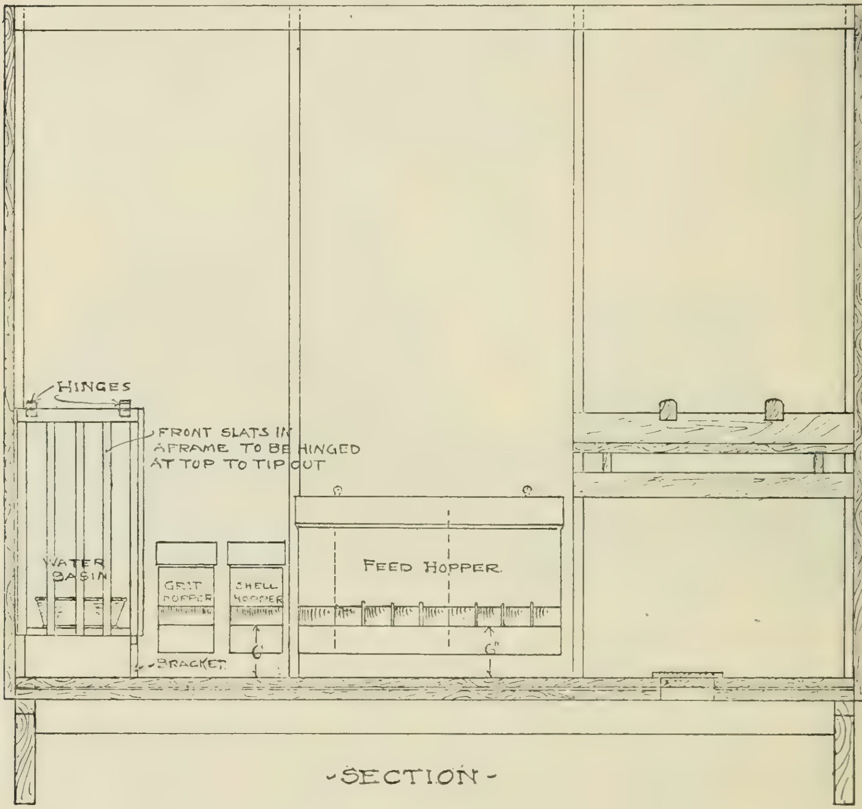


PLATE-VI.

points. A chicken may be trusted to be its own thermometer if given an opportunity to go to or to get away from the heat.

13. *Saves about three-fourths of the labor.*

It requires nearly four times as much labor to feed, handle and heat four flocks of 50 chickens each in small brooders as it does one flock of 200 in a large colony brooder house. The time and labor saved in heating one gasoline heated colony house containing 200 chickens compared to heating four brooders containing 50 chickens each, is even greater than

the labor saved in feeding and handling the flock by the two systems. With the gasoline system there are no wicks to trim because the heat is furnished by a combustion of gasoline vapor, which burns with a blue flame and should form no soot. The burner requires practically no attention for days and even weeks at a time. The quiet, humming sound of a properly working burner indicates that "all is well" without the necessity of even stooping down to look at the flame. When more or less heat is desired the size of the flame can be easily adjusted. During very warm weather when the gasoline flame must be turned entirely out, it requires more time to relight it than it would to relight a kerosene

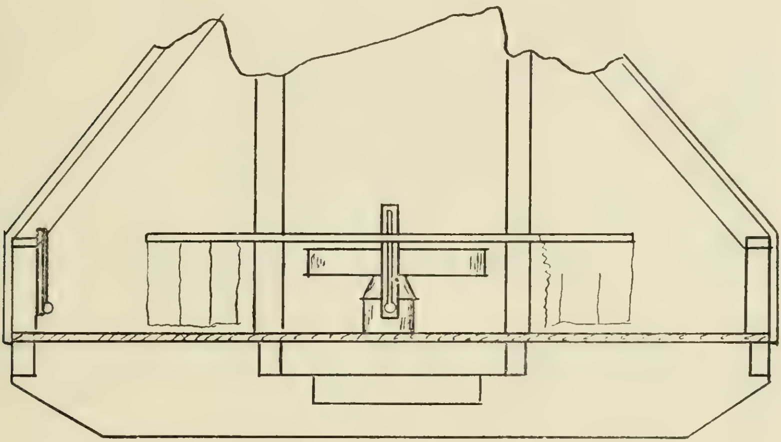


FIG. 76.—*Sketch showing location of thermometer and method of hinging the hover.*

burner. This is because of the necessity of waiting until the burner becomes hot enough to change gasoline into a vapor before the gasoline can be turned on and left burning.

14. *Economy of construction.*

The Gasoline-Heated Colony Brooder-House fitted with heater, piping, and all attachments, including labor complete, ready for rearing chickens, costs in Ithaca, N. Y., $37.46 for 200 chickens, which is a cost of 18.7 cents per chicken. The average price for outdoor brooders having a capacity of 50 chickens each is $12, an average first cost of 24 cents per chicken. The larger a brooder or colony house is, the less will be the first cost of construction per square foot of floor space or cubic foot of air space, other things being equal. The large continuous pipe heated brooder house, therefore, has the advantage over the colony house system so far as actual cost of construction per square foot of floor space and cubic foot air space per chicken is concerned.

15. *Both top and bottom heat.*

Either top or bottom heat taken alone does not seem to furnish the best conditions for successful artificial brooding. The system here described furnishes heat mainly from above by radiation, slightly by air warmed before entering the hover and in a small degree from the floor by contact. The burner box under the hover keeps the floor sufficiently

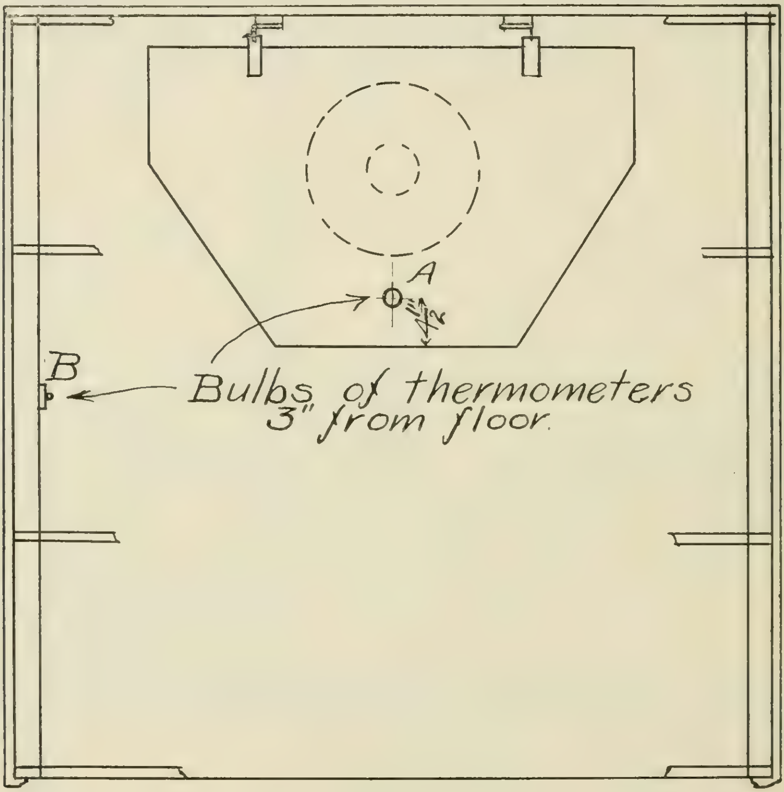


FIG. 77.

warm to insure dryness. The chill has been taken off so that the little chicks can lie down and stretch out comfortably, which is the natural position of very young chickens while sleeping.

16. *Adaptability to various conditions.*

The chief field of usefulness of the Gasoline-Heated Colony Brooder-House is the rearing of chickens in large numbers all the year round in latitudes south of New York State and all the year, except during the coldest winter months, in New York State and points farther north. For the rearing of winter broilers some of the individually heated brood-

ers in large, continuous brooder houses, would be more satisfactory on account of the saving of labor and economy of fuel. It is possible that gasoline could be used more satisfactorily for this purpose than kerosene or hot water heated with coal. We have not yet tried this method experimentally.

The plan for using gasoline as here described is not adapted to the rearing of chickens in small flocks. We have not yet succeeded in finding or making a burner small enough to satisfactorily and economically heat a small brooder. Therefore, until a gasoline burner is found which is adapted to small brooders, the person who intends to brood only 50 or 100 chickens at a time will be at a disadvantage in using the colony house as here recommended. The only alternative is to increase the hatching capacity and make fewer hatches during the season. Where a limited number of breeders is kept, this plan may not be feasible because it would require holding eggs too long before incubation, and might bring the hatches too far apart. Nevertheless, we believe it will be true economy in many instances to run the large colony house system with small flocks on account of the great saving of labor in caring for lamps and because of the fact that the house can be used all the year round.

17. *Placing the colony house.*

About the same amount of land should be provided for rearing chickens each year as is given to the mature fowls, the rule being that as many chickens should be reared each hatching season as there are fowls to be kept. This provides for rearing one-half the flock each year, assuming that about one-half the chickens will be pullets. This would mean that about one acre of land should be provided for every 400 to 500 chickens raised, and the same amount of land for 400 to 500 mature fowls kept.

A good disposition of the colony brooder houses is to place them in a large park surrounded by a 6 ft. narrow mesh poultry wire fence, the park being divided into temporary yards 150 ft. long and at least 50 ft. wide. This fence is used to prevent the chickens in the different houses from getting together until they are able to fly over a two and one-half to three foot fence, at which time the fence can be removed. Chickens of different ages should never be placed in the same house nor allowed to run in the same yards until they are well feathered.

18. *A summer house for cockerels.*

The principles involved in a good summer house for cockerels are shelter, an abundance of pure air, dryness, shade, plenty of perch room, convenient arrangements for feeding and cleaning, and a reasonable first cost. The summer house shown (Fig. 78) is offered as a suggestion.

These houses were built largely out of odd pieces of unmatched lumber and for that reason were covered with tough weather proof paper to avoid drafts. With good matched lumber, the building paper would not be necessary. These houses are 11 feet deep and 9 feet wide, four feet, six inches high in the rear and eight feet high in the front. Perches are placed through all of the houses as far front as the door. These perches should be made of 2 x 4 scantling with ends resting on cleats nailed to the sides of the house three feet from the floor. This will provide perch room for 150 to 200 young cockerels, which number is decreased by sales as they grow older and need more room. The young

FIG. 78.—*Summer house for cockerels on the range.*

stock from a number of these houses may run together on a common free range (Fig. 78) and all will return to their own houses with great regularity.

When first placed in the house they should be well fed and confined for a day or so, then let out for the first time late in the afternoon when they will not wander far away and will return to their own houses.

III. CONSTRUCTION OF THE BROODER-HOUSE.

The "A" type of house is eight feet square, inside floor measure, has 12 inch side walls and is six feet, six inches from top of floor to top of ridge board. The sub framing is made and both floors laid before the upper part of the building is put together. The sills are gotten out first.

They are made of 2 x 12 inch stock and are cut eight feet long with a bevel at each end to form runners or shoes upon which to draw the house about when desired.

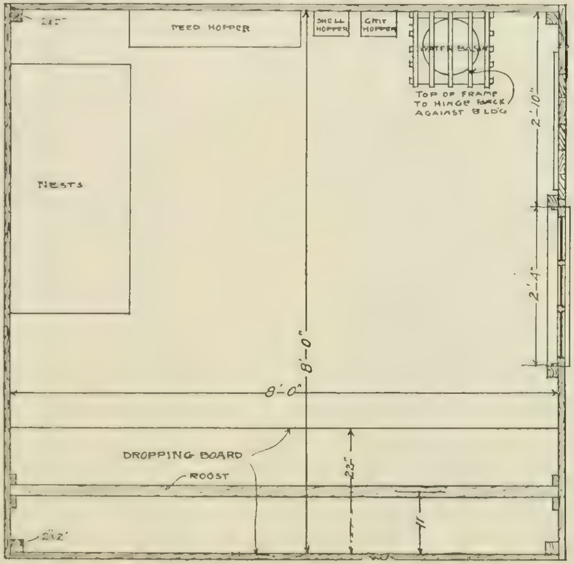
An opening of 8⅜ inches by 12 $\frac{3}{16}$ inches is cut in the rear runner to admit the burner box. (Plate II, Fig. 2.) The top of this opening is one and one-half inches from the top of the runner and has a one-half inch slit sawed into the runner horizontally from the two upper corners for the purpose of admitting the flange, or projection, of the upper edge of the burner box. A piece is cut from the runner directly over the center of this opening to admit the collar, which is on top of the burner box. The piece is sawed out on a mitre so that it can be replaced and secured by a single screw. (Plate II, Fig. 1.) The opening made by removing this piece is five inches in the clear.

A strip one inch square and 18 inches long is nailed to the inside of the runner one inch below the lower edge of the opening for supporting the rear end of the insulating box. (Plate III, Fig. 1.)

The floor joists, four in number, are made of 2 x 4 inch stock, cut eight feet long, and are fitted into the runners with a half joint. (Plate III, Fig. 2.) This gives a strong sub-frame that is not likely to get out of square when drawn over uneven ground. After fitting the joists into the runners and securely nailing with 20d nails, the work is leveled, squared, and tied by means of a one inch board nailed diagonally across the joists.

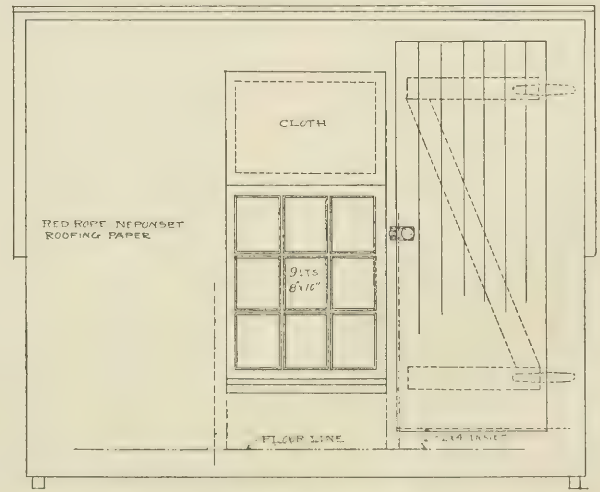
The support for the burner box is then put in. (Plate II, Fig. 1.) It is made of three pieces of 2 x 4 spiked to the rear runner and to the two center joists. It is placed flush with the top of the joists and runner so that the flooring can be nailed to it. The inside dimensions 13½ x 24½ inches are such as to allow the flange of the burner box to slide in easily. The flange rests on ½ x 1 inch strips which are nailed 1 $\frac{9}{16}$ of an inch below the top of the 2 x 4's forming the support. (Plate II. Fig. 1.) This leaves a space of one and one-half inches between the top of the burner box and the floor of the house which prevents the floor from becoming too warm and serves as a chamber in which to warm the fresh air that is admitted for ventilating the hover. The cool fresh air is taken from beneath the house through four one inch holes, bored in the 2 x 4 supports. (Plate II, Fig. 1, and Plate IV, Fig. 2.) It is warmed by passing over the metal top of the burner box and as it expands is forced upward around the stem and down upon the chicks.

The insulating box is made of seven-eighths inch matched pine flooring and is supported at the rear by resting on the strip at the bottom of the runner and in front by hooks and eyes, such as are used for screen doors, to the support. (Plate III, Fig. 1, and Plate IV, Fig. 2.)



- FLOOR PLAN -

FIG. I



FRONT ELEVATION.

FIG. 2

PLATE-VII.

The first or sub floor is made of one inch matched hemlock siding and is laid diagonally, which helps to stiffen the building. The finished floor is made of seven-eighths inch sap (white) pine flooring. This is blind nailed and is laid over a layer of building paper.

The studs are now put up. These together with the plates, rafters and ridge-board are made of ⅞ inch by 2¾ inch clear hemlock stock. The studs are placed flush with the outer edge of the floor and are toe nailed to it. The plates are laid on and nailed to the ends of the studs. The rafters are first nailed to the ridge-board and then put in place and toe nailed to the plates. (Plate IV, Fig. 2, and Fig. 64.) These are held in place temporarily by nailing a strip of board diagonally across them. The front and rear studs are fitted in place and then the boarding put on. The boards are put on horizontally and overlap the floor two inches.

The building is enclosed with seven-eighths inch matched siding planed one side, with the smooth side turned in. The boards for sides and the roof are cut in eight foot lengths, and since the house is to be eight feet square inside, a small space is left at each corner which is filled by a quarter round moulding, thus making it possible to use 16 foot stock without waste. (Plate III, Fig. 2.) The ends are boarded up solid, with the exception of the door opening. (Fig. 72.) After the paper has been put on, the casings for the windows are nailed in place and then the openings cut. By this method of construction no studs are required for the windows.

Best results have been secured by running the strips of roofing paper vertically (Fig. 72), instead of horizontally, as is generally recommended. The laps are made to come over the rafters and are covered with a ¾ x 2 inch batten. (Fig. 75 and front cover.) It requires much less time to put the paper on in this way and it presents a more pleasing appearance.

After the house is enclosed and doors and windows fitted and hung, the heater is put in place. (Plate I, Plate III, Fig. 1, Fig. 62 and 73.) To do this a circular opening, six inches in diameter, is cut in the floor towards the back of the house. The center of this opening is 19 inches from the back of the house and four feet from either side, inside measurement. The chick guard fits into this opening. (Plate II, Fig. 1 and Plate IV, Fig. 2.) The burner box is slid in from the back of the house (Fig. 73), and the stem telescoped down over the collar. (Plate III, Fig. 1.) The radiator is secured to the hover and telescopes over the top of the stem. (Plate III, Fig. 1.) The opening for the vent pipe in the back of the house is located so as to exactly correspond to the vent pipe coming out of the radiator. (Plate III, Fig. 1.) Great care

should be exercised in installing the heater as any loose fitting connections would cause leakage of gases into the hover.

The hover is made of seven-eighths inch matched pine flooring, planed both surfaces, and is held to the back of the house with detachable hinges as shown by Plate II, Fig. 1, and Plate IV. It can be raised and held up out of the way with a hook and eye or may be entirely removed while cleaning the floor of the house. (Fig. 63.) The front is supported by two pieces of broom stick serving as legs at each corner. It is enclosed by a double curtain of table oilcloth, unfinished surfaces together, reaching to within one inch of the floor. This is made into a fringe by a series of vertical slits four inches apart, extending upward six inches. The slits in the outer thickness of the curtain are made to break joints with those of the inner. (Plate IV, Fig. 2.) Table oilcloth is used in place of felt or woven cloth because the chicks eat the felt and are likely to become entangled in the ravellings from the woven cloth. It is also easier to keep clean. A hole is bored four and one-half inches from the front of the hover and the thermometer inserted so that the bulb is within three inches of the floor. (Plate IV, Fig. 2 and Figs. 63, 76 and 77.)

The gasoline tank is put in place by cutting a circular opening eight and one-eighth inches in diameter through the rear gable of the house. The inner end of the tank is supported by a piece of 1 x 6 inch board hollowed out to fit the can and fastened to the rafters. (Plate I and Plate II, Fig. 2, Plate III, Fig. 1 and Plate IV, Fig. 2.) It is secured at the rear end by nailing the square galvanized iron collar to the outside of the house (Plate II, Fig. 2 and Plate XV, Fig. 3), and at the inner end by wiring to the 1 x 6 inch support. The iron piping is now fitted together and the burner connected. (Plate III, Fig. 1, and Plate II.) All threads are well soaped over with soft soap before screwing together. When the burner is in place is should be so located as to be directly underneath the center of the stem. (Plate I.)

Figs. 65 and 66 show the colony house completed. These types of fronts seem to be the best, all things considered, that we have tested. (Fig. 75 shows two other types of fronts used.) The runners, as shown, are 12 inches high and are placed in the front and rear of the house. Runners six inches high have been tried with satisfactory results. The runners may be placed on the sides instead of the ends. This is sometimes advisable when the houses are to be used in orchards, because it allows the house to be drawn between the rows of trees with less danger of striking. Whatever the height of the runner, the burner box should be taken out before moving the house. If left in it might be bent out of shape by striking stones or uneven places in the land. To remove burner

box, raise hover, lift out stem, disconnect piping at union coupling (Plate III, Fig. 1) and withdraw box. Care should be taken that the wheel valve next to the tank is closed before disconnecting the pipe and that the lead gasket is not lost out of the union coupling.

Plates V and VI show how the house may be converted into a laying pen for 12 to 15 fowls by removing the heating plant and installing nesting and roosting arrangements.

IV. COST OF THE BROODER-HOUSE.

The following is a list of materials required to build the Gasoline-Heated Colony Brooder-House:

Runners:
- 2 pieces 2″ x 12″ x 8′.

Floor timbers:
- 4 pieces 2″ x 4″ x 8′.

Supports and covering, Insulating box for Burner box:
- 1 piece 2″ x 4″ x 2′ 6″.
- 2 pieces 2″ x 4″ x 2′ ½″.
- 15 sq. ft. ⅞″ matched pine flooring.

Sheathing for Sub-floor:
- 80 sq. ft. ⅞″ matched hemlock siding.

Building paper to go between floors:
- 80 sq. ft. "A" grade Red Resin Building Paper.

Finished floor:
- 80 sq. ft. ⅞″ sap white pine flooring.

Studs:*
- 8 pieces ⅞″ x 2¾″ x 11⅛″.
- 2 pieces ⅞″ x 2¾″ x 4′ 9″ front.
- 2 pieces ⅞″ x 2¾″ x 4′ 4″ rear.

Plates and Ridge Board:*
- 3 pieces ⅞″ x 2¾″ x 8′.

Rafters:*
- 8 pieces ⅞″ x 2¾″ x 6′ 9″.

Sides, End, Door and Roof:
- 220 sq. ft. ⅞″ hemlock siding.†

Door Battens:
- 2 pieces ⅞″ x 4″ x 1′ 11″.
- 1 piece ⅞″ x 4″ x 3′ 10″.

Hover:
- 20 sq. ft. ⅞″ pine flooring.
- 2 pieces ⅞″ x 4″ x 3′ 8″ (battens).
- 2 pieces broom stick 10″ long (supports).
- 2 yds. white table oil-cloth (fringe).

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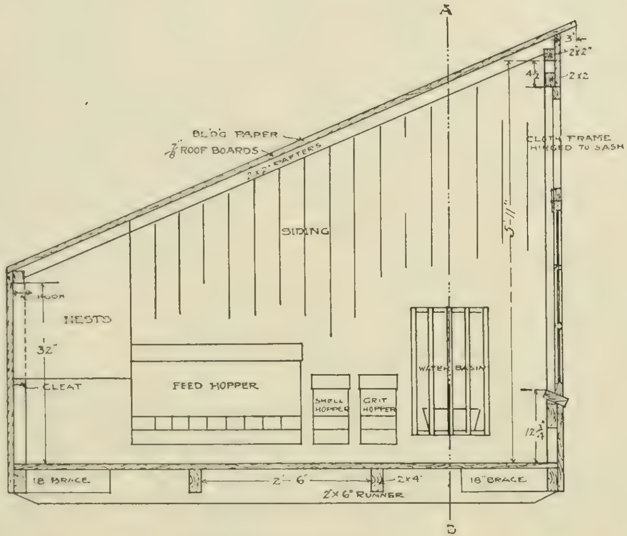
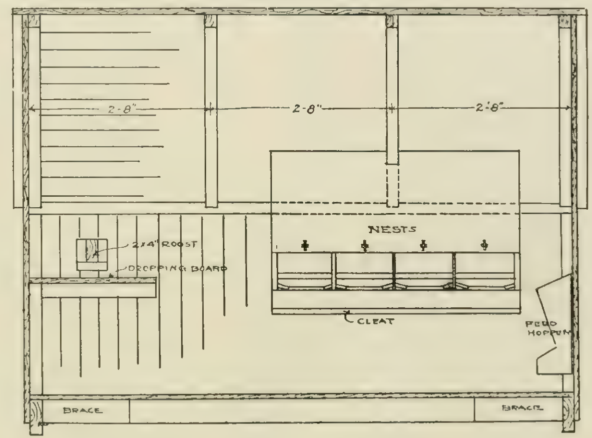
* Clear hemlock planed four surfaces.

† Unless well seasoned hemlock can be obtained, ⅞″ sap (white) pine flooring should be used even though it cost $5 or $6 more per M.



SEC·THRU·HOUSE

FIG. I



SECTION ON LINE·A—B·

FIG. 2

PLATE-VIII.

Roofiing paper for covering entire house except door, windows and runners:
 250 sq. ft. Neponset Red Rope Roofing, caps and nails.

Paint for covering roofiing paper (2 coats).
 1 gal. lead and oil paint.

Hardware for door:
 1 pair 6″ strap hinges, heavy pattern.
 1 horizontal rim knob latch.
 1 piece galvanized hardware cloth 6″ square, ¼″ mesh.

Front Windows:
 2–3-lighted, 1⅛″ cellar sash, 8″ x 10″ glass.
 2 pair 3″ strap hinges, light pattern.
 2–3-stop sash adjusters.

4 pieces ⅞″ x 2″ x 2′ 4″ white pine. 2 pieces ⅞″ x 4″ x 17½″ white pine. 2 pieces ⅞″ x 3″ x 17½″ white pine.	casings.

Rear Window.
 1–3-lighted 1⅛″ cellar sash, 7″ x 9″ glass.
 1 pair 3″ strap hinges, light pattern.
 1–3-stop sash adjuster.

2 pieces ⅞″ x 2″ x 12⅝″ white pine. 1 piece ⅞″ x 4″ x 2′ 5″ white pine. 1 piece ⅞″ x 3″ x 2′ 5″ white pine.	casings.

Nails:
 1 lb. 20d nails for floor framing.
 10 lbs. 8d nails for upper framing, boarding and flooring.
 2 lbs. 6d nails for casing and door.
 1 box carpet tacks for hover fringe.

Thermometer:
 Any good brooder thermometer registering from 50° to 160° or 180° F.

Purchasing List.

1 piece 2″ x 12″ x 16′. 2 pieces 2″ x 4″ x 16′. 1 piece 2″ x 4″ x 8′. } rough hemlock @ $24 per M	$1.42
300 sq. ft. ⅞″ matched hemlock siding @ $25 per M	7.50
80 sq. ft. "A" grade Red Resin Building Paper @ 75 cts. 500 sq. ft.	.12
100 sq. ft. ⅞″ matched sap pine (white) flooring @ $35 per M	3.50
2 pieces clear pine (casings and battens) ⅞″ x 8″ x 10′ @ $40 per M.	.54
7 pieces ⅞″ x 2½″ x 16′ @ $24	.68
Planing above four surfaces @ 5 cts. per piece	.35
1–3-lighted cellar sash 7″ x 9″ glass @ 45 cts.	.45
2– 3-lighted cellar sash 8″ x 10″ glass @ 50 cts	1.00
250 sq. ft. roofing paper (nails and caps)	2.50
1 pair 6″ strap hinges, heavy pattern @ 20 cts	.20
3 pair 3″ strap hinges, light pattern @ 8 cts	.24
1 horizontal rim knob latch @ 15 cts	.15
3–3-stop sash adjusters @ 20 cts	.60
1 lb. 20d nails @ 3 cts	.03
10 lbs. 8d nails @ 3 cts	.30
2 lbs. 6d nails @ 3 cts	.06

1 piece hardware cloth, ¼″ mesh, 6″ x 6″ @ 5 cts.	$0.05
1 gal. paint @ $1.75	1.75
2 yds. oil-cloth @ 30 cts.	.60
1 box carpet tacks.	.02
Thermometer	.50
Heater complete*	10.00
Total cost of material	$32.46
Cost of constructing, (two carpenters one day)	5.00
Total cost of building	$37.46

Price of lock, hinges and sash adjusters includes screws.
Above prices show the actual cost of materials and labor in Ithaca and will, of course, vary in different localities.
Heater includes all metal parts shown on Plate 1 except filling can. The heaters for use at this station are made by local tinsmiths, whose names and addresses are herewith given. * Plate 1 is a working plan by the aid of which any good tinner should be able to construct the heater.

* Made by Treman, King & Co., Ithaca, N. Y., and L. R. Lewis, Cortland, N. Y.

V. Operation of the Brooder-House.

To operate this house in January and February weather requires about half a gallon of gasoline per day, costing at the present rate of 15 cents per gallon, less than seven cents per day. During the warmer weather, April and May, the cost is much less, as low sometimes as two cents per day to brood the 200 chickens. The cost to operate the house for a period of 29½ days, together with figures showing the thermometer readings taken both outside, inside at the front of the house, and under the hover, is shown by Figs. 76 and 77, and Table I. Page 176.

The brooder is run for the first week or ten days so that the thermometer, located as mentioned above, gives a reading of 90° F., at the same time the thermometers placed under other parts of the hover would show a range of temperature from 90° to 103° F., thus making it possible for the chicks to get almost any degree of temperature from 60 out in the room, to 103 under the hover.

Fig. 74, shows how the tank is filled from the rear of the house. The burner should always be turned out and the wheel valve closed while the tank is being filled. To light the burner, open the wheel valve (W. W., Fig. 74), and the control valve (Fig. 67), and allow the gasoline to almost fill the generating cup, then close. Light the gasoline and allow it to burn out. Open the control valve and hold a lighted match over the top of the burner. This will give a bright blue, cone-shaped flame which should never be turned so high as to show red. Regulate to the desired temperature with the control valve.

There is no danger whatsoever in operating a gasoline burner provided ordinary care is exercised. The common points of error often resulting disastrously are: (a) allowing too much gasoline to run into

the generating cup (G. C., Fig. 67); (b) applying a match to the generating cup before the control valve is closed; (c) attempting to light the burner after it has been blown out by the wind or in some other manner and the bottom of the burner box is covered with gasoline. With this type of heater, this occurrence is very rare since the burner is placed back under the house where the wind cannot reach it. Should the flame by any accident be extinguished and the burner become cool and so waste gasoline into the burner box, the control valve should be closed as soon as it is discovered and the gasoline allowed to evaporate entirely before any attempt is made to relight the burner. As an extra precaution a basin may be placed outside under the drip to prevent waste and also to avoid gasoline filtering into the soil. A tin flashing should be placed above and below the burner box on the back side of the house as an extra precaution against fire.

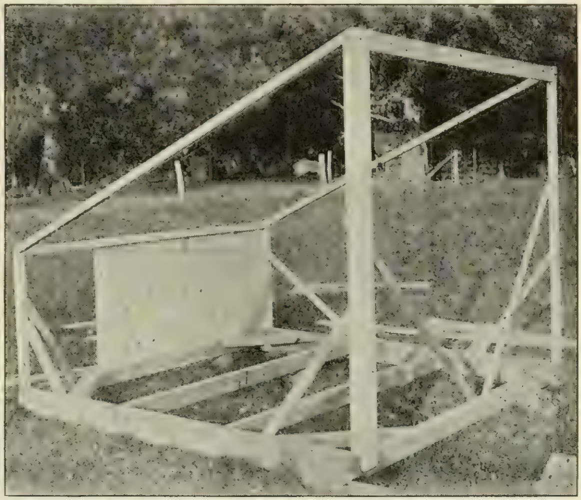


FIG. 79.—*Frame work of roof shed of colony house.*

Should any difficulty be experienced in getting a large enough flame to maintain the proper temperature under the hover during cold weather, the burner should be examined for stoppage. It sometimes happens that little particles of sediment in the gasoline clog the opening (o) at the needle end of the control valve. (Fig. 67.) This can be remedied by closing the control valve and forcing the point of the needle through the opening in the valve seat (Fig. 67). This will clear away any obstruction that might be there. It might be difficult to get a sufficiently large blaze because the opening above referred to is too small. This may be remedied by opening the control valve so that the point of the needle will be back out of the way and then drawing a file at right angles across the hole, thus enlarging it.

The burner used is the Dangler* Furnace and Laboratory Lamp Burner, No. 154. This burner has been selected for use in the Gasoline-

*The Dangler Stove Co., Div., Cleveland, Ohio.

Heated Colony Brooder-House as the result of a long test. It has been found to be better than the ten or twelve other types of burners used because it gives a cone-shaped blaze that is directed up into the radiator where it is needed instead of being sent out in jets at right angles to the burner. It gives more complete combustion than the cap type of burner and is capable of a wider range of temperature, that is, it can be turned very low for use in mild weather; or will give a flame sufficiently large to maintain the proper temperature under the hover when it is 10° to 15° below zero outside. Burners with more than one control valve are to be avoided. Among the burners tested there were a number which had two or three wheel valves and in addition to these a needle control valve. This type of burner is undesirable because it is too complicated for the busy poultryman, is likely to get clogged and upon trial does not prove to be so satisfactory as the burner with only one needle control valve. Fig. 71, shows seven representative types of burners tested, six of which were found to be unsatisfactory.

Fig. 70 illustrates the two principal types of burners. No. 2 is the Dangler burner and gives a pointed, cone-shaped flame very much like a Bunson burner; No. 1 is the Omaha* burner. It is a cap burner and sends the flame out in small jets at right angles to it. It was found that a great deal of heat was wasted because it was not directed upward into the radiator.

Fig. 62 represents the heater. (BB) is the burner box, which slides under the house through the rear runner, working on the principle of a table drawer. (Fig. 73.) (S) is the stem, which telescopes over the collar on the burner box and conducts the heat up into the radiator (R), where it circulates upward and over the diaphragm (see Plate I), and out of the vent pipe (V. P.). (C. G.) is the chick guard which fits in the hole made in the floor of the house. (Fig. 63.) This prevents the chicks from coming in contact with the stem (S) and serves as a passage for bringing the warmed, fresh air into the hover.†

*Omaha Stove Repair Co., Omaha, Neb.

† The brooding system which is here described and shown, is covered by ns existing patent as far as we know. Any person or manufacturer is free, so far ao we are concerned, to use these plans but must assume all risk of litigation on account of alleged infringements.

This system of brooding by the use of gasoline-heated colony houses is given free to the public with the request that credit shall be given by manufacturers by placing the following statement on all heaters which they make.

GASOLINE HEATER
AS DESIGNED AND USED BY THE
NEW YORK STATE COLLEGE OF AGRICULTURE,
ITHACA, N. Y.

VI. ANOTHER TYPE OF COLONY BROODER-HOUSE.

Since the shed-roofed type of colony house is preferred by some poultrymen, it is deemed advisable to incorporate in this bulletin photographs and working plans of a shed-roofed colony house which is being used at this station with fairly good results. (Plates VII, VIII and Figs. 79, 80.) It costs a little more to build than the "A" type of house of the same floor space and is not so convenient for the attendant doing the work inside. The runners should not be more than eight inches high. The other floor framing is the same as for the "A" house, except the braces in the corners. The shed-roofed house is not so strong a form of construction and so these braces are put in to stiffen it. The upper framing is made of 2 x 2 inch stock and is covered with seven-eighths inch matched boards, plain side in and roofing paper on the outside.

FIG. 80.—*The shed roof type of colony house.*

The house can be used with a gasoline heater and is also convertible into a pen for 12 or 15 laying hens. If a gasoline heating plant is installed the tank should be placed in the upper left-hand corner of the house upon a shelf and the pipe run outside and around the building into the burner box. This requires a little more pipe than the "A" house.

A FEW SUGGESTIONS WORTH REPEATING AND REMEMBERING IN OPERATING THE GASOLINE-HEATED COLONY BROODER-HOUSE AS DESIGNED AND USED BY THE NEW YORK STATE COLLEGE OF AGRICULTURE.

1. See that the house stands level. If it tips forward, the gasoline which would flow if the flame should be extinguished, would remain in the burner box instead of escaping outside by the trough provided for the purpose. (Plate I.)

2. Fasten firmly to the house, the pipe leading from the supply tank to the burner so that the burner shall remain rigidly in place under the center of the stem leading to the heater drum. Otherwise the heat will be lost.

3. Do not leave the hover raised without first extinguishing the flame. The wind is likely to blow down the stem of the heater and put out the flame, which would allow the gasoline to escape. (Fig. 63.)

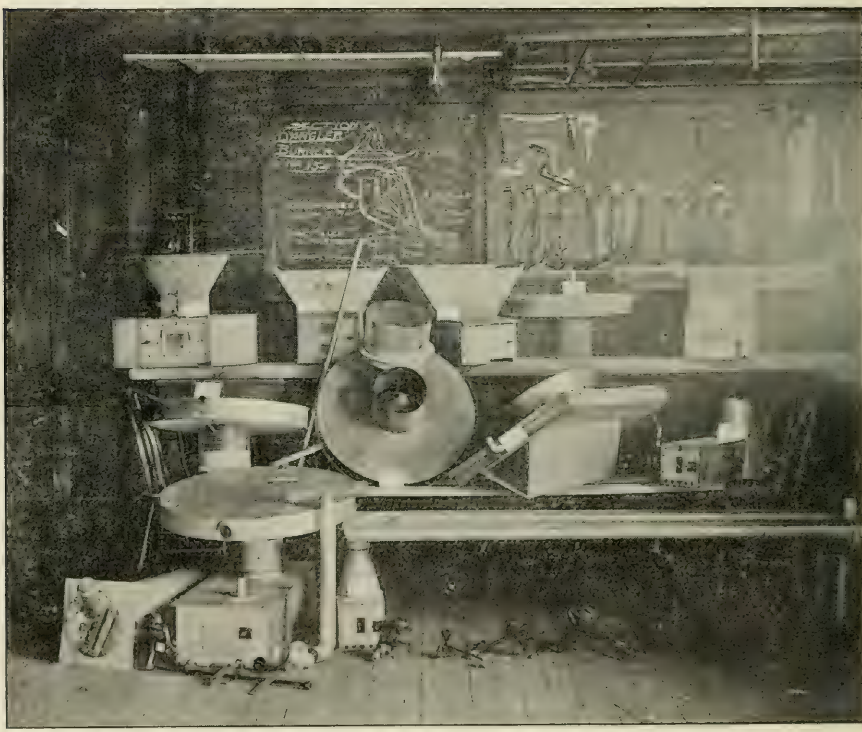


FIG. 81.—*A symposium of some of the heaters which were made at Cornell University and discarded in an effort to invent one which would be safe, of reasonable cost, durable, economical of fuel and which would supply a large amount of heat. Some of the difficulties encountered, were, first—to provide a fire proof burner box that would furnish sufficient fresh air to the burner and at the same time would not be affected by heavy winds. Second to secure a continued supply of pure, moderately warm but not super-heated air under the hover from outside the house. Third—to hold the hot air within the heater drum long enough to supply radiated heat from above down upon the chickens.*

4. Never ignite the burner while there is gasoline or gasoline vapor free inside the burner box. If gasoline has escaped, wipe out the burner box thoroughly and allow a little time to elapse before igniting in order

to let the vapor escape from the heater drum, thus avoiding an explosion of the gas.

5. Place a tin flashing about the burner box on the back side of the house as an additional safeguard to protect the woodwork. The same precaution should be applied to all brooder systems.

6. The use of a taper or hand torch for igniting the burner where many burners are used, will save time and matches.

7. While lowering the hover, care should be taken lest a chicken become caught where the stem joins the heater or where the heater joins

FIG. 82.—*The range at Cornell where chickens grow strong and lusty in sunshine and shade on the free range of green pastures.*

the pipe which conducts the fumes outside the house. This would stop the draught and the heater would not work. (Fig. 63.)

8. The temperature of the house outside the hover is quite largely controlled by the glass and cloth window openings which should be adjusted to suit the weather and direction of prevailing winds. (Figs. 65, 96, 74 and Plate IV.)

9. Always extinguish the burner and shut the wheel valve when filling the supply can and guard against filling the tank to overflowing.

10. When lighting the burner, do not fill the generating cup to overflowing, and do not ignite the burner while the control valve is open. (Fig. 67 and 68.)

11. Keep the gasoline supply underground or in a shady location to prevent loss by evaporation.

12. It is well to keep a few pieces of asbestos wicking for repacking the burner if occasion should demand it. (Fig. 68.)

13. To avoid delay, it is well to have an extra burner on hand to replace one which may fail to work properly.

14. While there is less danger from fire with gasoline when used as here recommended, nevertheless, it is well to be prepared for fire by having a fire extinguisher or water supply at hand in case of need. It will be a wise precaution and profitable investment, whatever system of brooding is employed.

15. When the chickens no longer need heat, empty the supply tank, remove the heater and store in a dry place to avoid rusting.

TABLE I.—TEMPERATURE RECORD.

From Feb. 28 to March 29, Inc.

DATE.	MORNING.			EVENING.		
	Outside house.	Inside house.	Under hover.	Outside house.	Inside house.	Under hover.
Feb. 28	7	14	90	32	42	100
Mar. 1	14	22	89	40	54	102
" 2	37	44	96			95
" 3	36	36	94	24	44	90
" 4	15	27	93	25	44	93
" 5	20	32	40	40	60	100
"; 6	15	32	90	19	46	94
" 7	0	11	84	31	56	101
" 8	28	38	94	30	52	110
" 9	26		87	33		85
" 10	33	40	85	34	52	95
" 11	16	40	116	34	59	84
" 12	30	38	80	38	50	85
" 13	39	50	93	36	49	82
" 14	86	55	90	30	45	79
" 15	33	48	92	44	57	80

TBALE I—TEMPERATURE RECORD—Concluded.

DATE.	Morning.			Evening.		
	Outside house.	Inside house.	Under hover.	Outside house.	Inside house.	Under hover.
Mar. 16	30	45	98	50	63	88
" 17	44	54	90	46	72	98
" 18	30	46	90	41	74	100
" 19	30	36	75	37	50	77
" 20	28	45	92	32	64	100
" 21	36	46	90	49	62	89
" 22	41	58	89	72	81	92
" 23	44	49	86	55	63	82
" 24	45	50	72	39	54	86
" 25	35	46	84	54	68	70
" 26	33	48	81	61	72	93
" 27	52	59	90	58	63	96
" 28	60	68	85	64	70	86
" 29	56	64	86	74	82	88

* For location of thermometers see Figs. 76 and 77.
Average outside temperature, 40.18.
Average room temperature, 47.96.
Average hover temperature, 89.
Total hours operated, 706.
Gasoline consumed, 12 gallons.
Amount of gasoline consumed in one day—24 hours, .407 gallon. Cost of operating one day—24 hours, $.061.
Cost of brooding one chick one day, $.0003. Cost of brooding one chick as long as it needs heat (est.), two months—60 days, $.018. (Winter or early Spring.)
Time saved by this method of brooding, i.e.: (time required to fill and trim four kerosene lamps) est., 15 minutes per day, equals 15 hours for the brooding season at 15 cents an hour, equals $2.25.

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Agronomy

THE IMPORTANCE OF NITROGEN IN THE GROWTH OF PLANTS

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ITHACA, N. Y.

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ORGANIZATION

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THE IMPORTANCE OF NITROGEN TO THE GROWTH OF PLANTS,*

Being a statement of a point of view.

The problem stated.

The thesis of this paper is that a limiting factor in the growth of crops may be the amount of water-soluble nitrogen occurring in the soil at a critical time in the plant's life history. Further, that in humid climates, the effect in many instances, perhaps in the majority of instances, of the various cultural methods employed to increase the yield of crops is to modify the amount of water-soluble nitrogen in the soil at the time when and at the place where needed by the plant. It is important to observe that I use the indefinite and not the definite article. I shall maintain that the amount of water-soluble nitrogen is a limiting factor, not necessarily the limiting factor.

That by a systematic rotation, the yield of crops is increased by reducing diseases and insect enemies there can be no question. If a muck soil lacks potash, crops may be increased by supplying the needed element. What I shall undertake to show, or perhaps better, to suggest, is that on the majority of agricultural soils in the humid climate of Eastern United States the water-soluble nitrogen is likely to be a limiting factor and that the effect of the various successful cultural methods is to increase the water-soluble nitrogen at the critical time in the plant's life history.

Should this contention be established by this paper or better, by further more careful and far-reaching investigations, it is believed that the results will have special, practical application to the North and South Atlantic States.

The importance of nitrogen in the growth of plants.

The experiments and observations here reported do not prove the assumptions just made, but it is believed the evidence is of such a nature as to make a thorough investigation of the subject desirable. Some of the queries which I will raise will be for the purpose of suggesting lines of investigation rather than indicating conclusions reached.

While the writer of this paper has been connected more or less closely with most of the experiments here reported, the data has in every

* This paper was first presented on October 17 and 24, 1906, to the Agronomy Seminary of the New York State College of Agriculture; an abstract was submitted on November 12, 1906, to the Society for the promotion of Agricultural Science at Baton Rouge and the paper was again read on November 27, 1906, before the Normal Institute for Farmers' Institute Workers, held at the New York Agricultural Experiment Station.

instance been collected by others, to whom credit will be given. I have not attempted to give all the data of any of these experiments, but only such as seem to have a bearing directly or indirectly on the question under consideration. On the other hand, I have tried to give faithfully all the data that might influence a judgment on the subject. Some of the data presented tends to disprove the thesis of the paper and for this reason, if for no other, further investigations are desirable.

Difference between nitrogen and other elements.

As a matter of course, every element has one or more characters which distinguish it from other elements or it would not be recognized as a separate element. It may be well to recall some of nitrogen's characteristics. It is no part of the original earth's crust. It belonged exclusively to the atmosphere to which it tends constantly through denitrification, to return, while other forces tend to add it to the soil. In its normal atmospheric condition it is not directly available to any higher plant, in which it differs from oxygen and carbon-dioxid, both of which are taken freely from the atmosphere by all higher plants. The nitrates of the soil differ from the phosphates in that they move through the soil readily and are easily removed therefrom by leaching. Potash salts are also readily removed from the soil but, unlike the phosphates, they occur in the original earth's crust in comparatively larger quantities.

The function of nitrogen.

The living part of all plants is protoplasm. The element which above all others concerns us in the production of proteids is nitrogen. This is about all that is positively known about the function of nitrogen in the growth of plants. The usual statement is that the green color of plants is due to chlorophyll and that chlorophyll, for its normal development, requires iron. Every one knows that the immediate result of applying soluble nitrogen to the soil is to cause vegetation to assume a greener color. Just what part does nitrogen play in bringing about this result? If it were demonstrated that nitrogen played a direct part in making plants green, it would be completely demonstrated that nitrogen acted directly as a plant-food.

Relation of total and water-soluble nitrogen.

Since in this paper, the discussion largely concerns water-soluble nitrogen, it is desirable to state exactly what is meant by water-soluble nitrogen and what is its relation to total nitrogen and what relations have either to the needs of plants.

The Bureau of Soils has developed a method of determining the water-soluble nitrates which consists of stirring a given weight of soil in

twice its weight of water for three minutes, then allowing it to stand for thirty minutes, after which the water is poured off, filtered through a Chamberland filter and the nitrates in this extract determined. Whether this conventional method of determining the nitrogen in the soil is a measure of the nitrogen available as plant-food is, of course, open to debate. In this paper it is assumed that the water-soluble nitrate is a measure of the available nitrogen. Ammonia compounds have been shown, however, to be available to certain crops. The water-soluble nitrogen is stated as the acid radical NO_3 in parts per million of dry soil. It is important to note that if the amount of nitrogen determined by this method represents the nitrogen actually in solution in the soil, then stating the nitrogen in parts per million of dry soil does not show the concentration of the soil solution. Suppose a soil containing 10 per cent. of moisture contained 30 parts of NO_3 per million of dry soil, then a soil containing 20 per cent. of moisture should, on the above assumption, contain 60 parts of NO_3 if the soil solutions have an equal concentration of NO_3.

It is also important to recognize that the water-soluble nitrogen is an extremely small part of the total nitrogen of the soil. During 1905, Bizzell found, as the result of 32 determinations, that on August 21, Dunkirk clay loam growing alfalfa contained 6,910 parts of total nitrogen stated as NO_3 in each million pounds of dry soil, while on the same soil on the same date as the result of 96 determinations there were 49.7 parts of water soluble NO_3. In other words, there were 139 times as much total nitrogen as water-soluble nitrates. It must be apparent to every one from these statements that the methods that have thus far been employed are open to many objections. Nevertheless, I think some progress is being made in the study of these soil questions.

The purpose of cultural methods.

The Lord said, "Let there be light, and there was light." No one doubts that light was of prime importance in the creation of the world and still is an important factor of plant growth.

That too little or too much heat or moisture may be injurious to plants does not admit of discussion. Further it is well known that different species have adapted themselves to different amounts of light, heat, and moisture. In 1901 the yield of maize was 1,522 million bushels in the United States, in 1902 it was 2,523 million bushels. No one doubts that this was due in the main to differences in sunshine, heat and rainfall. That the precipitation is of vast importance and often the controlling influence in the yield of crops has been demonstrated by many experiments. It goes without saying that plants cannot be built up of ten

chemical elements unless these elements exist in a form available to the plants at the proper time and place.

There is no doubt, either, that injurious substances, such as alkali, may prevent the growth of plants, nor that certain substances, such as lime, may be injurious to some plants while highly beneficial to others. The question is not whether the various factors are important: in fact they are all essential; but what influence do approved agricultural methods have in modifying these factors and thus increasing the yield of crops? Of two farmers one raising 40 bushels of maize, and another by different cultural methods which we call superior because of the results, producing 60 bushels, the question is which of these essential factors has he modified? Of two pieces of land cultivated precisely alike one produces 40 and the other 60 bushels. What is the cause? Has the light, heat, moisture or plant-food been different? Or have fungous diseases, insect enemies or injurious chemicals in the soil been the determining factor in the yield? Or is it a combination of many factors? And if so, by what rational method may we hope to modify these factors so as to increase the yield? Why do the states of the Mississippi Valley produce over 30 bushels of maize per acre and the South Atlantic States less than 15 bushels per acre? Is it light, heat, moisture, plant-food or toxic substance? Who will venture an answer?

There was a time in so-called scientific agriculture when all practices were based on the theory that the various cultural methods modified the quantity of plant-food, the amount of which could be mathematically determined. Then followed a period in which the conservation of soil moisture was insisted on as the important factor in crop growth and farmers were advised to modify their cultural methods accordingly. Now comes the doctrine of soil sanitation; that soil may become unhealthy for the successful growth of crops and that our aim must be to so manipulate and dose our soil as to make it healthy. It is perhaps not without some significance in this connection that for 2,000 years the value of the rotation of crops has been recognized, while some of the reasons stated for its beneficial influence, even in the most modern discussion of the subject, would hardly bear critical analysis. I may say by way of parenthesis that notwithstanding the advice given to farmers during the past 75 years, they still continue to grow crops. I think I may say without fear of contradiction that there never was a time in the United States when so much agricultural product was produced per unit of labor as at the present moment.

The conservation of moisture.

The writer confesses to have taken part in the propaganda concerning the conservation of soil moisture. At least 15 years ago he conducted

an investigation which indicated clearly that cultivation of the soil did not necessarily conserve soil moisture; that in a humid climate it might in fact decrease the soil moisture, since stirring wet soil tends to increase evaporation; and, further, that under some circumstances it was conceivable that this was beneficial. However, he has held strongly that weeds are harmful because they exhaust the moisture from the soil and that stirring the soil may increase the moisture in the soil even though it does not decrease the evaporation or even increase it, because the stirred, and hence looser soil, will absorb and hold more of the rainfall, both by preventing it from running off the surface and by preventing the water absorbed from draining away below the reach of the plants. I do not now say that these things are not as I formerly believed. What I do say is that these conclusions are too largely inferences based on pot experiments and the whole question needs to be gone into *de novo* under normal field conditions.

The influence of early and late spring plowing on corn production.

In the year 1903, Modesto Quiroga conducted a thesis on "The influence of early and late spring plowing upon corn production."*

The land, which was a silt loam, had been in maize the previous year. Six plats, each 40 x 2 rods, were laid out and each alternate plat plowed April 7, while the remaining three plats were plowed June 3, which was the day before all the plats were planted to maize. Samples were taken on each half of each plat at one, two and three feet in depth, thus making 36 samples at each determination. The per cent. of water was determined weekly from April 6th to September 29th. The water-soluble nitrogen was determined April 6th and weekly beginning June 3d until September 29th. Weekly temperatures were recorded from June 6th to September 22d. The rainfall was exceedingly low, being 13.36 inches for the six months April to September inclusive, while the normal is probably not far from 20 inches. During the growing period, June to September, the total rainfall was but 8.09 inches. In a favorable season, the land on which this experiment was conducted would easily raise 60 bushels of maize per acre.

In this summary only the surface foot is dealt with, both on account of simplicity in presentation of results and because the other figures would add little to the point under discussion.

The first point of interest is to observe the per cent. of moisture and the amount of water-soluble nitrogen in parts per million of dry soil on

* Published in June, 1904, as Ohio State University Bulletin, Series 8, No. 28, Agricultural Series No. 1.

April 6th just before the early plowed plats and on June 3d just before the late plowed plats were plowed:

TABLE I. EFFECT OF EARLY AND LATE PLOWING.

	Early.	Late.
Water, per cent. April 6	27.3	26.0
Water, per cent. June 3	28.3	21.7
NO_3 p.p. million of dry soil, April 6	6.2	5.8
NO_3 p.p. million of dry soil, June 3	35.4	20.8

From this table it will be seen that up to the time of planting, viz., during April and May, the moisture had been conserved by the early plowing and a marked increase in soluble nitrogen had occurred due to plowing. The increase in moisture was 13 per cent. while the increase in soluble nitrogen was 70 per cent.

Next we will examine the conditions during the growing and ripening period. The data is divided into two parts, the first part consisting of the data for June and July when intercultural tillage was given and the largest visible growth made, and the second part consisting of data for August and September, when the crop made its largest increase in weight of dry substance and ripened. There is evidence to show that it is during the first part that the plant takes up the largest proportion of its nitrogen and during the latter part that the greatest demand is made upon the soil for water.

Omitting the samples of June 3 taken before the late plowed plats were plowed and, of course, before the maize was planted, the average percentage of water and the amount of nitrogen in parts per million for each period were as follows:

TABLE II. WATER AND NITROGEN DURING GROWING SEASON.

	PART I. JUNE AND JULY.		PART II. AUGUST AND SEPTEMBER.	
	Early plowed plats, per cent.	Late plowed plats, per cent.	Early plowed plats, per cent.	Late plowed plats, per cent.
Water	22.5	23.2	15.9	15.2
NO_3	32.8	21.7	13.3	7.1

The total yield of field cured maize stover was almost identical upon both the early and late plowed plats, being at the rate per acre of 4330 and 4313 pounds respectively, while the yield of grain was at the rate per acre of 32.7 bushels on the early plowed and 26.0 bushels on the late plowed plats or a difference of 25.8 per cent. in the yield of grain in favor of early plowing.

It thus appears that both plats started out in the early part of the season to grow equal crops of maize, but in the latter part of the season the late plowed plats fell behind.

What caused this difference in yield? Everyone must admit that the percentages of moisture as found from week to week were not materially different but that the proportion of available nitrogen was materially different. It should be remembered that this being a season of drouth, it would be expected that the per cent. of moisture would be the critical factor, if it is ever modified by early and late plowing. Was, then, the excess of available nitrogen the cause of the difference of yield, or did the greater growth of maize on the early plowed plats, exhaust more moisture? That is, did the maize plants on both plats take all the moisture they could and finding more upon the early plowed plats, thus produce more crops? If both the early and late plowed plats had been kept entirely free from vegetation, would the early plowed plats have shown a greater percentage of moisture than the late plowed?

The average temperature throughout the four months was 68.8° F. on the early and 70.4° F. on the late plowed plats. Quiroga says, "that the amount of moisture in the soil seemed to be the controlling factor in determining the temperature." However that may be, a prime difficulty in assigning an influence to the temperature, is our lack of knowledge as to whether the lower or higher temperature was the most desirable.

Difference between soil and subsoil.

The relative amount of moisture and nitrogen in the first, second and third foot of soil is not without some significance in this connection. The new Athletic field has recently been stripped of its surface soil. Why is this subsoil less productive than the soil? Is it on account of its ability to hold water, or on account of the difference in available nitrogen, or is it due to still other causes?

The following table gives the relative quantities of moisture and nitrogen at the three depths, including all determinations from April 6 to September 29:

TABLE III. NITROGEN IN SOIL AND SUBSOIL.

		Water per cent.	NO_3 in parts per million.
Surface foot	Early	21.6	19.9
	Late	20.4	12.5
Second foot	Early	21.6	6.7
	Late	20.5	6.2
Third foot	Early	20.4	4.4
	Late	19.9	3.1

Influence of weeds. (Experiment by Cates.)

During the winter of 1904-5 and during the spring and summer of 1905, Cates conducted at Cornell University a variety of investigations to determine what was the reason or reasons for the well known detrimental influence of weeds, especially when allowed to grow in an intertilled crop. Attention is called to four of 13 plats on which maize was raised during 1905. The soil was Dunkirk clay loam. During May and August the rainfall was below normal; during June and July above normal, being during June double the normal precipitation.

Maize was planted on May 29th. Plats 1 and 4 were cultivated throughout the whole period of growth, viz., about once in ten days from June 14 to August 22d. On June 14 plat 2 was cultivated when series I was sown to rye, series II to millet and series III allowed to grow to weeds without further cultivation. Plat 3 was cultivated June 14 and again June 27, when each series was treated as plat 2.

The conditions under which these three series were conducted make it impossible to compare one series with another. It is only possible to compare the plats of a series with each other. Below is given the average per cent. of moisture taken at intervals between June 27 and August 25. In series I and III five determinations were made on each plat; on series II four determinations:

TABLE IV. PERCENTAGE OF MOISTURE ON CULTIVATED AND "WEED" PLATS.

PLAT.	TREATMENT.	Series I, Maize with rye.	Series II, Maize with millet.	Series III, Maize with weeds.
1	Cultivated	24.7	27.7	26.8
2	"Weeds" after June 14	22.0	24.8	21.3
3	"Weeds" after June 27	23.6	24.9	22.3
4	Cultivated	26.3	28.3	24.6

The main value of these different series lies in the duplication of results. In these trials clearly the plats on which the "weeds" grew contained less moisture than on similar made plats kept cultivated. The next table gives the yields of maize and weeds obtained:

TABLE V. GIVES THE YIELDS PER PLAT OF MAIZE AND "WEEDS."

SERIES I. MAIZE WITH RYE.

PLAT	Green weight of maize, lb.	Green weight of "weeds," lb.	Field cured stover, lb.	Ear maize lb.	Height of maize stalks ft.
1	216.9		59	46.3	7.6
2	105.2	75	38	21.5	5.6
3	131.1	78	38	35.0	5.8
4	239.0		63	48.0	7.1
	SERIES II. MAIZE WITH MILLET.				
1	122.5		38	33	
2	49.1	100	30	3	
3	73.4	48	38	13	
4	130.2		40	38	
	SERIES III. MAIZE WITH "WEEDS".				
1	103.8		33	35	
2	53.9	42	26	11	
3	104.1	45	42	32	
4	172.1		47	58	

It is noticeable that the yield of ear maize was much greater where weeds were not allowed to start until June 27 instead of on June 14, although the difference in the percentage of moisture in both series of plats is nearly the same. This is the period when maize needed an abundance of nitrogen but is not likely to suffer for want of moisture. The amount of water-soluble nitrogen is shown in the next table:

TABLE VI. GIVES THE DETERMINATION OF THE WATER-SOLUBLE SALTS AND NITROGEN

PLAT.	SERIES I. MAIZE WITH RYE.			SERIES II. MAIZE WITH MILLET.
	Total salts p.p. million June 27	Total salts p.p. million Aug. 25.	NO_3 p.p. million Aug. 25.	NO_3 p.p. million Aug. 8.
1	600	329	160	23.0
2	644	180	15	7.3
3	551	226	29	7.4
4	519	329	165	71.5

While the number of determinations here given and the time they were taken are not such as to base any important conclusions on, they show as far as they go a great decrease in the water-soluble nitrogen where the weeds grew and the land was not stirred as compared with plats which were stirred and no weeds allowed to grow.

I still have some other results to present, but taking the case thus far presented was the less yield of maize due to decrease in supply of water, to decrease in supply of water-soluble nitrogen, to decrease in supply of other water-soluble salts, or to other causes?

Influence of stirring the soil.

The influence of stirring the soil is shown by the results from the following three plats: Plat I was cultivated eight times between June 14 and August 22. On plat 2 the weeds were removed or kept from growing by scraping the surface with a hoe with as little disturbance of the crust of soil as possible. On plat 3 the weeds were allowed to grow after the first cultivation which took place on June 14.

TABLE VII. INFLUENCES OF STIRRING THE SOIL.

		Plat I Cultivated.	Plat II. Surface scraped.	Plat III. Weeds.
Green maize, lb		98.5–113	88–111.5	53.2–77
Stover, lb		33.0–33	29–30	26.0–21
Ears, lb		35.0–28	32–28	11.0–9
Water per cent.*		26.2	22.4	22.5
NO_3 p.p. million	Aug. 22	115	26	31
	Aug. 28	30	16	14
	Sept. 29	46	16	14
	Oct. 6	63	54	32
Total soluble salts p. p. million	July 14	455	644	775
	Aug. 28	459	217	196
	Sept. 7	327	366	310
	Oct. 6	256	259	252

* Average of eight determinations.

It will be seen that in this trial the plats which were scraped so as to prevent the growth of weeds, but the soil not stirred, yielded nearly as well as those that were stirred thoroughly in removing the weeds. On the other hand the yield of grain was greatly reduced upon those plats on which weeds were allowed to grow after the first cultivation. It would seem, therefore, that it was the weeds and not the stirring of the soil that caused the principal injury to the growth of maize, although stirring the soil seems to have been slightly beneficial. This has been repeatedly demonstrated, especially at the Illinois Station. When we come to examine the water and soluble nitrogen content, it is found that

in a general way they were substantially equal on weed and scraped plats while on stirred plats both were higher. It is extremely unfortunate that the nitrogen content was not determined early in the season at the time when it is presumably most needed by the maize. However, the gist of this test is to suggest that the failure of the maize to properly develop was due to other causes than lack of water or available nitrogen.

Root interference.

In undertaking to explain the influence of weeds, Cates grew a maize plant in each end of two rectangular boxes. In one of these boxes he placed a partition; in the other no partition was used, but the roots of the maize plants were allowed to intermingle freely, which they did. Other boxes were arranged in like manner with a maize plant in one end and rye and in other cases millet at the other end.

The result was that the amount of top was somewhat smaller and the amount of root decidedly larger when the two maize plants had their roots separated. In like manner, the top of the maize plant was larger when the rye growing in the same box was separated from the roots of the maize. The millet only slightly influenced the growth of maize. These experiments need to be repeated with a sufficient number of checks before important conclusions are drawn from them. Cates, in offering an explanation for the results, has ascribed it to root interference, thus showing that the gridiron may add to scientific nomenclature.

Influence of weeds.

During the season of 1906, Hosford conducted an experiment on 20 plats at Cornell University to determine the influence of weeds on the growth of maize. This experiment was conducted on the Dunkirk series, the soil varying from quite a sandy loam to a clay loam. The following table gives the percentages of moisture and total yield of green fodder on the check plats which were cultivated in the ordinary manner throughout the usual season of cultivation:

TABLE VIII. INFLUENCE OF TEXTURE OF SOIL UPON MOISTURE CONTENT AND ITS RELATION TO YIELD OF MAIZE.

South Series.		North Series.	
Water per cent.	Maize fodder lb.	Water per cent.	Maize fodder lb.
17.8	762	14.7	903
16.0	731	13.8	904
15.1	778	11.9	859
14.6	972	10.6	1001

Here there are eight plats treated precisely alike which varied in moisture from 10.6 to 17.8 per cent. and in yield of green maize fodder from 731 to 1001 lbs. The differences in the percentages of moisture in these plats are due to the character and perhaps the topography of the soil, the lower percentages being on the sandier and higher ground. In general the lower the percentage of moisture the larger the yield of maize. It is extremely unfortunate that the proportion of water-soluble nitrogen was not determined on each of these plats.

It is well known that sandy soils will not retain as much water as those containing a higher percentage of clay, but that plants can avail themselves of lower percentages of water in the sandy soil. The purpose of giving this table is to show how careful one must be in interpreting the results of soil moisture determinations. Suppose one is making a pot experiment using a made soil by mixing soil, sand and manure as is customary, and he does not secure an equal mixture in the different pots, what value would be the results of soil moisture determination?

The following table gives the percentages of moisture and the yields of maize and weeds from two plats which were cultivated in the ordinary manner and two which received one cultivation on May 15, six days after the maize was planted. One of these was allowed to grow up to native seeds while the other was sown to millet on May 15. Plat 462N will be explained hereafter:

TABLE IX.—EFFECT OF CULTIVATION AND "WEEDS."

	Plat 461 cultivation.	Plat 462 millet.	Plat 462N millet and weeds.	Plat 463 weeds.	Plat 462 cultivation.
Water in soil, per cent..........	17.8	16.9		15.5	16.0
Maize fodder, green substance, lb. per acre....................	23,622	2,139	6,834	4,061	22,661
Millet or weeds, green substance, lb. per acre..................		10,881	22,440	10,106	
Total green substance, lb. per acre.	23,622	13,020	29,274	14,167	22,661
Maize stover, field cured lb. per acre........................	3,410	775	816	1,364	3,224
Maize ears, lb. per acre..........	2,914	16	612	62	3,069

This table shows that the growth of millet or weeds greatly checked the growth of maize, the yield of green substance where the millet was sown being only one-tenth and where weeds were allowed to grow only one-fifth that produced under ordinary cultivation. Of course the stalks on these weedy plats produced practically no ears and was, therefore, virtually a failure. This table also shows that the total green product

produced on the weed plats was much less than where cultivated in the usual way. It will also be seen that the percentage of moisture was only slightly less on weedy than on cultivated plats. Does it follow, then, that the yield of maize was not influenced by the need for moisture or was the growth of the maize checked by the diversion of some of the water from the maize to the "weeds?" Manifestly the weeds required some water to produce them. If this water had not been employed in producing weeds, would it have been raised in producing maize? It seems almost impossible to plan an experiment which will directly answer this question, since we do not know the relative evaporation of the relative run off from cultivated soil as compared with soil covered with weeds. There would seem to be two reasons, however, for believing that while the available water may have been a factor in checking the growth of maize there must have been some other influence, also. First, the total product produced was not as great on the weedy plats as on the cultivated plats; and, second, it is entirely probable that in a dry season all the plats would have had a lower percentage of moisture and yet the cultivated plats would have produced more maize than the weedy plats produced this year.

The following table gives the water-soluble nitrogen (NO_3) in parts per million of dry soil on the cultivated plat 461 and on the millet plat 462 at dates mentioned and plat 462N to which nitrate of soda was applied as explained hereafter:

TABLE X. VARIATIONS IN WATER-SOLUBLE NITROGEN.

	461 Cultivated plat.	462 Millet plat.	462N Millet and nitrogen.
May 31	56.4	40.	
June 11	80.	80.	
June 22	73.9	60.	
July 2	96.	10.	
July 8	68.5	11.5	21.8
July 19	52.7	7.5	48.0
July 30	12.3	3.8	160.0
Aug. 16	26.0	7.3	320.0
Aug. 21	10.5	9.6	218.2
Aug. 29	6.2	2.8	282.5

Up to June 22 no difference in the growth of maize could be observed which could be attributed to the weeds. On July 2, however, a difference in the color of the maize upon the millet plat was plainly observable. The millet was about as high as the maize. Hosford further reports that the maize was about the same size on both these plats on

this day. A few days later when observed by the writer the maize on the cultivated plat was considerably larger, more sturdy and of a much darker green color.

It will be noted that, on July 2, the cultivated maize plat contained 96 parts of NO_3 per million of dry soil while on the maize and millet plat but 10 parts were found. It was reasoned that if the lighter green color and smaller size of the maize where millet grew was due to lack of nitrogen then the addition of nitrate of soda should cause the maize to recover its green color and grow more rapidly than where maize and millet was not so treated, although the maize could not be expected to catch up to the maize on the cultivated plat at that stage in its life history. If plants do not grow normally in season they cannot be expected to recover their growth out of season. Accordingly twice the amount of nitrate of soda necessary to supply 86 parts per million of dry soil to 2,000,000 of soil or to the depth of 8 inches was applied to 35 hills of the maize plat known as 462N on July 6, 14, 21, and 27 or four applications in all. At the end of the first week, or on July 14, both the maize and the millet were much greener than the rest of the plat not so treated, but it could not be said with certainty that the growth was greater although it seemed a shade larger: on July 18, however, the hills were distinctly larger than the other hills of the millet plat and as green as the plants on the cultivated plat.

An examination of the third column of Table X will show that only a part of the water-soluble nitrogen applied was found upon analysis. This is to be expected since part of it will become fixed by the soil, part of it taken up by the growing vegetation, part of it may drain or wash away and some may be denitrified. The interesting thing is that between July 30 and August 16, the water-soluble nitrogen increased from 160 to 320 parts of NO_3 while all nitrate of soda was applied sometime previous to the earlier date.

If the table IX is now examined it will be noticed that the yield of green maize fodder was over three times as great on the millet plat where nitrate of soda was applied and the yield of millet was over twice as great, making the total green product more than twice as great where the nitrate was applied. Furthermore, this increased yield of material was made without changing materially the water content of the soil. From July 8 to September 29, the time during which this increased growth was made the average of six determinations shows the per cent. of water to be 15.1 where nitrogen was applied and that where nitrogen was not applied 15.1. In other words, the per cent. of moisture was identical although the growth of crop was doubled. Can anyone escape the conviction that decrease in growth was in the first instance due in part to

a lack of water-soluble nitrogen needed as plant-food and that the subsequent increased growth was due directly to the nitrogen applied and that it served as plant-food? Does it not seem plausible that weeds by taking up a portion of the small amount of nitrogen available just at the critical period in the life of the maize plant or other plant which is being cultivated, may cause the injury so commonly observed?

Factors influencing supply of water.

It may be said that it is impossible that both the above plats should show the same per cent. of moisture since the greater amount of vegetation must have required more moisture. It does not necessarily follow that because a plant actually uses a larger amount of water that it dries the soil more than one which uses a less amount. It would of course, if the evaporation, the run off and the amount of drainage, remained the same, but evidently they do not as the following incident will illustrate. On June 13, Quiroga found in the surface foot, 26.9 per cent. of moisture. During the next six days the rainfall was .28 of an inch. The largest possible amount of moisture to be found in that soil at a depth of one foot would be 29.6 assuming a cubic foot of soil to weigh 75 pounds. The actual amount found was 25.6, or a difference of four per cent. During the next 12 days the rainfall was 1.11 inches. The largest possible amount of moisture to be found was 35.6 inches; the actual amount found was 27.4 or a difference of 8.2 per cent. Obviously, if on a portion of this soil for other causes than the supply of moisture, vegetation grew more vigorously it could use a part of the water which would otherwise go to waste, and thus not necessarily reduce the percentage of moisture found in the soil.

The importance of nitrogen in growing alfalfa.

Attention is next called to a series of observations on alfalfa as illustrating the importance of nitrogen in growing crops. The Cornell Station has published (Bul. 237) some experiments showing that on Dunkirk clay loam three things are necessary to the successful culture of alfalfa; lime, manure and inoculation. What do nodule bacteria do? What does lime do? What does manure do?

(1) *What do nodule bacteria do?*

What are the characteristics of legumes? First, to produce a product containing a high percentage of nitrogen. In the case of some of our cultivated legumes, such as alfalfa, very large amounts are laid up in the plant in a very short space of time. A second characteristic of legumes is to bear nitrogen-gathering bacteria. Is this an accident? It

goes without saying that large amounts of nitrogen cannot be laid up in plants without the plant having the power to secure it from some source. Is it not the plain inference that legumes which require large amounts of nitrogen in a short space of time, could not acquire this nitrogen without nitrogen-gathering bacteria because the soil ordinarily does not have sufficient nitrogen available at the right time? If all soils contain sufficient plant-food for the support of plants, why do legumes bear nodules?

(2) *What does lime do?*

At the Cornell Station in the spring of 1905, certain plats were sown to alfalfa, portions of which were limed and portions left unlimed. It was found in this instance as in similar experiments, that when Dunkirk clay loam was limed, alfalfa grew much more vigorously than when it was not limed. (See Cornell Bul. 237.) Bizzell determined the water-soluble NO_3, P, K and Ca at intervals throughout the season. No marked differences were found in the water-soluble phosphoric acid or the potash, although slight differences were found, but marked and unmistakable differences in the water-soluble nitrogen were found. Bizzell found as an average of 16 determinations at each of three dates, July 20, August 21 and September 22, 65.9 parts of NO_3 in the limed portion and 33.5 parts in the unlimed portion, almost exactly twice the amount on the limed as compared with the unlimed portion. This difference was found notwithstanding the fact that the alfalfa, on account of its greater growth, had required more nitrogen.

Lipman raises the question whether the lime had been the cause of the increase in water-soluble nitrogen and thereby increased the growth of the alfalfa, or whether the lime had exercised in some way a beneficial influence upon the nodule bacteria which were the cause of the increased growth of the alfalfa. He states that he has demonstrated that proteid nitrogen can be excreted into the soil by legumes, although he has not demonstrated that it is soluble. He contends, therefore, that it is possible that the increased growth of alfalfa may have been the cause of the greater quantity of water-soluble nitrogen instead of the result of it. In the spring of 1906, therefore, plats were sown to alfalfa, to timothy and to alfalfa and timothy, and one-third of each was limed, one-third received nitrate of soda at the rate of 320 pounds of nitrogen to the acre and one-third was left untreated. Assuming the nitrate of soda to become distributed in 2,000,000 pounds of dry soil this would be an application of 117 parts of NO_3 per million of dry soil.

The idea was that if the amount of water-soluble nitrogen was increased by liming through an increased nitrification of organic matter,

that the timothy should grow better on the limed portion if it also grew better where nitrate of soda was added. If increase in water-soluble nitrogen was the result of the increased growth of alfalfa and not the cause of it, then the water-soluble nitrogen should be greater upon the limed alfalfa plat than upon the limed timothy plat.

The following table gives the average results of samples taken at seven dates, May 22 to September 5 by Clark and determined by Bizzell:

TABLE XI SHOWS PARTS OF NO_3 PER MILLION OF DRY SOIL AS AFFECTED BY LIMING, ALFALFA AND NITRATE OF SODA.

	Limed 2,000 lbs. per acre.	Untreated.	Nitrate of Soda 320 lbs. per acre.	Average.
Alfalfa	3.98	36.6	46.9	41.1
Timothy	32.6	35.4	41.1	36.4
Alfalfa and Lime	40.8	33.4	50.9	41.7
Alfalfa	36.4	33.5	53.4	41.1
Average	37.4	34.5	48.1	

It should be stated that the effect of lime on the growth of alfalfa has thus far in this experiment been very much less marked than in any previous experiments which we have conducted. Since there was very little apparent effect of lime on growth it could not be expected consistently that much difference in water-soluble nitrogen would be found if the water-soluble nitrogen is related to the growth of alfalfa.

It will be seen by examining the above table that only small differences were found. Such differences as exist, however, tend to indicate a greater amount of water-soluble nitrogen on the limed alfalfa than upon the limed timothy and less upon the limed timothy than the unlimed timothy. It is also interesting to note that the amount of water-soluble nitrogen averages less on all timothy plats than on the alfalfa plats, which suggests that the alfalfa may have secured parts at least of its nitrogen from the air and thus made less demands upon the soil for nitrogen than did the timothy.

Another factor enters into this experiment. The series of untreated plats were in a depression while the limed and nitrate of soda were on the sides of this depression. The influence of this is shown in the following table, the results being an average of seven determinations as stated above:

TABLE XII. SHOWING PERCENTAGE OF WATER IN PLATS TREATED AS IN TABLE XI.

	Limed.	Untreated.	Nitrate of Soda.	Average.
Alfalfa	17.0	18.2	18.3	17.8
Timothy	16.6	18.3	17.5	17.4
Alfalfa and lime	17.4	18.3	16.9	17.5
Alfalfa	17.4	18.7	16.4	17.5
Average	17.1	18.3	17.3	

It will be seen from this table that while the percentage of moisture was higher in the untreated plats, the amount of water-soluble salts stated in parts per million of dry soil was less; hence it follows that there was a greater difference in the concentration of the soil solution in favor of the limed area than is indicated by the figures.

The figures here reported are not sufficiently decided to permit of any definite conclusions, but they clearly indicate that here is a line of investigation worth following up.

(3) *What does manure do?*

During the season of 1906, it was noticed at the Cornell Station that on certain alfalfa plats the alfalfa was in well marked streaks. First would be a strip of dark green, vigorous alfalfa about six inches wide followed by a strip of lighter green, smaller and apparently less vigorous alfalfa. At first it was thought to be due to differences in inoculation, since the differences observed were just such as are well known to be produced by inoculation. An examination showed that inoculation was not in this case the cause of the difference there observed. On further investigation it was found that in plowing, the stable manure had been left in the soil in strips instead of being evenly distributed and that where the roots of the alfalfa were in connection with the manure or immediately over it the alfalfa was green and vigorous while where there was no manure the alfalfa was smaller and lighter green in color. It was also observed in the experiment mentioned when discussing lime that young alfalfa plants were greener and slightly larger where nitrate of soda was added than where it was not applied. The plain inference is that the increased growth observed as caused by the manure was due to the nitrogen which the manure was able to supply.

Earthworms.

During the season of 1906, it was observed that the maize on the Mitchell farm was extremely uneven. Some hills of maize would be large, vigorous, stocky and of deep green color while hills immediately adjacent would be small, spindling and of a decidedly lighter green color. Gilmore, on having his attention called to the possible role of nitrogen, made an examination of these hills. He found that where the hills were large they were over a lump of manure while where the hills were small the manure was absent. Figures 83 and 84 illustrate the conditions just described. The writer happening along after these hills were photographed observed that there were some earthworms clinging to the roots of the larger hill. Notwithstanding this hill had been taken up some hours previously and removed some distance from where it grew, a count showed 48 earthworms at work in the manure and earth clinging to the roots of this hill. The smaller hill was next examined and not an earthworm was found. Examinations were then made of other large and small hills. Even larger numbers of earthworms were found in some of the larger hills and some were also found in the smaller hills but always less in number and smaller in size.

FIG. 83.—*Corn stalk which grew above a block of manure;* 48 *earthworms were found in the block of earth on the roots. Under another larger stalk* 60 *worms were found.*

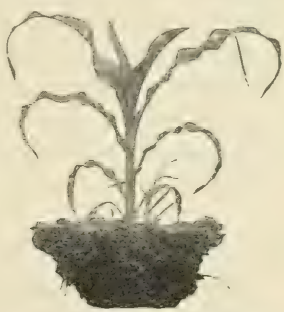

FIG. 84.—*Corn stalk which grew over no manure. No earthworms were found in the block of earth. Another stalk about the same size had* 2 *and another a little larger had* 18 *earthworms and also a little manure. On same scale as Fig.* 83.

Were these earthworms incidental, like so many tumble bugs in cow's droppings, or do they play some important part in making plant-food and especially nitrogen available? It is said that in Southern England

a great wave came in from the sea and overflowed a large tract of land that thereafter became sterile. Investigations by Dymond indicate that the amount of salt deposited was not sufficient to cause sterility. This condition was attributed in part to the killing of the earthworms.

Of course it will be understood that should earthworms prove to be an important factor in the growth of crops, as long ago pointed out by Darwin, it will be primarily a matter of furnishing the best conditions for their multiplication and growth. A study, therefore, of the best conditions for the growth of earthworms may be advisable and may lead to better and more rational cultural methods.

Conclusions from alfalfa experiments.

What are the inferences to be derived from these observations on alfalfa? The reason for inoculating alfalfa is to supply it with nitrogen from the air. The reason for applying lime is to make the nitrogen available, although it may yet be necessary to prove whether it has a direct or indirect influence. The reason for adding stable manure is to supply a source of nitrogen which may readily become available. I do not contend that lime and stable manure may not do other things. I contend they do these things. That is sufficient for my present thesis.

The occurrence of an excess of water-soluble nitrogen.

The discussion of a subject of this kind is somewhat like trying to convict a man for murder on circumstantial evidence. It is only on the accumulation of considerable evidence that a conclusion may be safely reached. In fact, it may be well that this is not a subject that can be safely electrocuted, but one in which life imprisonment only is indicated.

I wish now to call attention to some observations of quite a different character, but all apparently having some relation to the nitrogen problem. On the Mitchell farm there are two areas that failed to raise crops in 1905. One will be called the cabbage spot because it failed to raise mangel wurzels and cabbages and the other the timothy spot because it failed to raise timothy.

The history of the cabbage spot is as follows: In the spring of 1905 an old timothy meadow was plowed and the portion under consideration was planted to mangel wurzels. On a large circular area about 90 feet in diameter, the mangels died when plants were quite small. This area was planted to cabbages. These cabbages lived, but at the end of the season they were about the size of a man's hand while on a nearby area, which three field agent experts of the Bureau of Soils declared to be identical in all outward appearance, 35 tons of cabbage were raised per acre.

Here, then, was a piece of land which would not under the very best of cultivation raise either mangel wurzels or cabbages, while land apparently in every way identical raised satisfactory crops. It is a commentary on our knowledge of plant growth to be compelled to confess that neither scientific investigations or practical experience offered any explanation.

At this juncture the Bureau of Soils offered to send a detail of men to work on any soil problems the Cornell Station might suggest. The problems involved by these poor spots were investigated by Breazeale, Brown, Read and Eckmann, assisted by Clark of Cornell, from about November 1 to May 1. Without going into details with regard to either the cabbage or timothy spot, it may be stated that the soil on the poor spots when tested according to the basket method grew better crops than the soil from the good areas, and plants grown in the soil extracted behaved in a similar manner. Further, the only difference discovered between the poor and good spots was a much higher percentage of water-soluble nitrogen on the spots that in the previous season did not grow crops. For example, samples of soil from the "good" and "poor" cabbage spots were analyzed by the Bureau of Soils with the following results, the samples being taken in December:

TABLE XIII. ANALYSIS OF SOIL EXTRACT FROM CABBAGE SPOT STATED IN PARTS PER MILLION OF DRY SOIL.

	NO_3.	PO_4.	K.	Ca.	Mg.
"Good"	48	7	6	21	4
"Poor"	96	6	4	32	7

After a number of tests of the soil and water extract on both the cabbage and timothy areas had been made the author of this paper suggested that since the only difference thus far discovered between the poor and good spots was the percentage of water-soluble nitrogen, it would be desirable to add sufficient nitrate of soda to bring the good soil to the same water-soluble nitrogen content as the poor soil and then determine whether plants behaved alike in both. Samples of both soils were taken and analyzed by Bizzell. The poor soil contained 106.5 parts and the good soil 9.6 parts per million of dry soil. Since all soils have the power of taking salts from solution and fixing them, it was necessary to keep adding nitrate of soda until the right amount of water-soluble nitrogen was found. In this case it required 135.4 parts of NO_3 to increase the water-soluble nitrogen 96.9 parts per million of dry soil.

Wheat was then grown by the basket method in so called good and poor soil and in good soil to which sufficient nitrate of soda was added to give it the same water-soluble nitrogen as the poor soil:

TABLE XIV GIVES THE GREEN WEIGHT IN GRAMS OF 30 WHEAT PLANTS BY BASKET METHOD UNDER EACH OF THE VARIOUS TREATMENTS, AS DETERMINED BY REID.

	Poor timothy.	Good timothy and nitrate.	Good timothy.
Check	11.2	10.3	7.6
320 P	10.4	11.1	7.1
80 K	11.3	10.9	8.4
160 N	10.1	9.4	8.5
320 P+160 N	11.3	11.0	8.8
160 N+ 80 K	11.0	10.5	9.1
320 N+ 80 K+320 P	10.4	12.2	10.5
Average	10.8	10.6	8.6

Whatever else may be said of these figures, it must be admitted that when the water-soluble nitrogen was made equal, the growth of wheat seedlings was equal, while where the amount of water-soluble nitrogen was unequal the growth was unequal.

It is just as easy for me to believe that the cause was a direct one as an indirect one.

The question still remains unsettled, however, as to why these spots of soil refused to grow crops, in the one case mangel wurzels and cabbages and in the other case timothy. Was it due to the excess of water-soluble nitrogen or did the fact that crops failed to grow and thus failed to consume the water-soluble nitrogen, cause it to accumulate in the soil? Were the water-soluble salts the cause or the result of such failure? I think the latter is probable and that, therefore, the cause for the failure of these areas to grow the crops mentioned is yet unsolved.

The temporary fluctuating character of water-soluble nitrogen.

I shall now proceed to detail some experiments showing the temporary character of water-soluble nitrogen and the influence of vegetation. In his investigations last winter, Clark extracted the water-soluble salts from the good and poor cabbage soils by the stirring of a quantity of

water equal to twice the weight of soil for three minutes and allowing it to stand and pouring off, this being the conventional method now employed for determining the water-soluble salts. If this extraction is a measure of the plant-food, then there was no plant-food in the soil after this operation.

The soils thus treated and soils not extracted were then allowed to stand for a month in open jars without the addition of water, so that they became in appearance very dry before the end of the period. Cabbages were then raised by the basket method in this leached soil and also in the soil which had not been leached as shown in figure 85 with the following results:

TABLE XV. SHOWING GREEN WEIGHT IN GRAMS OF CABBAGES ON POOR AND GOOD CABBAGE SPOTS LEACHED AND UNLEACHED.

	Unleached.	Leached.
Good	7.7	9.5
Poor	20.8	27.3

TABLE XVI. SHOWING THE NO_3 IN PARTS PER MILLION IN ORIGINAL SOIL NOT PLANTED, AND SOIL FROM SAME SOURCE AFTER CROP HAD BEEN GROWN, SAMPLES FOR ANALYSIS BEING TAKEN TWO MONTHS AFTER ORIGINAL SOIL WAS LEACHED BUT IMMEDIATELY AFTER CROPS WERE REMOVED IN CASE OF SOIL GROWING CABBAGES.

	Original Soil.		Soil Having Shown Cabbage.	
	Unleached.	Leached.	Unleached.	Leached.
Good	64	48	22.5	Trace
Poor	240	200	64.	Trace

Apparently not the only factor in the growth of crops is the amount of water-soluble nitrogen, since leaching improved the growth of cabbage, both on the good and poor spots; but whatever this untoward influence may have been, which the leaching appeared to eliminate, it was very small compared with the apparent influence of water-soluble nitrogen.

This experiment brings out two possibilities of the highest significance. It appears from this experiment that a soil leached of its water-

soluble nitrogen may in the course of a month recover a sufficient concentration of water-soluble nitrogen to grow cabbages successfully, assuming the soil to contain a sufficient quantity of total nitrogen,; and second that a plant may under favorable conditions consume nearly all the water-soluble nitrogen, so that crops on two soils having contained unlike quantities of water-soluble nitrogen may grow unequally, consuming unlike quantities and thus leaving the soil with like quantities of water-soluble nitrogen. A statement of the soluble nitrogen in the two soils just after they have raised, say, in one case six bushels of wheat and in another case 30 bushels of wheat would, therefore, be as misleading as to try to judge the contents of a man's stomach from the food remaining on the table after a meal. Of what use can water-soluble nitrogen

FIG. 85.—*Cabbages grown on leached and unleached soils.* 1, *Good soil unleached;* 2, "*poor*" *soil unleached;* 3, *good soil leached;* 4, *poor soil leached. Soils in bushels* 2 *and* 4 *contained high percentages of water-soluble nitrogen, while in bushels* 1 *and* 3 *they contained low percentages.*

be to plants unless they use it? A man cannot expect to grow fat unless he eats the food placed before him. If he eats it, the food will no longer be on the table.

Influence of nitrate of soda on water-soluble nitrogen when applied to timothy.

To show that this is not theory as applied to plant growth under field conditions the following experiment is here presented:

To Plat 725 and 728 of our regular timothy fertilizer series were applied on 17th of April, 320 lbs. nitrate of soda, 80 lbs. muriate of potash and 320 lbs. acid phosphate. On May 8th, 320 lbs. of nitrate of soda were also applied to plat 728. On May 31 and on July 11 the latter being the date of harvesting, samples of soil were taken by Clark

and analyzed by Bizzell, on these two plats and also on plats 726 and 729, both being untreated plats adjacent. (See Cornell Bul. 241.)

A sample of the field-cured hay from each were taken and the percentage of water and nitrogen determined.

Table XVII. Showing Pounds of Water-free Hay, Nitrogen Added and Recovered and NO_3 in Soil at Dates Mentioned.

Plat No.	Treatment.	NO_3 in soil May 31—July 11.	Lb. dry matter per acre.	Nitrogen in dry matter per cent.	Nitrogen per acre. lbs. Recovered.	Added.
725	320 lbs. Nitrate of Soda	4.3–4.8	5673	.79	45	50
726	Nothing	4.6–5.3	2439	.83	20	0
728	640 lbs. Nitrate of Soda	6.2–3.8	5803	.96	56	100
729	Nothing	2.4–2.7	1980	.83	16	0

Of one thing there can be no doubt, viz., that more nitrogen was recovered where nitrate of soda was applied. That proportionately larger amounts were not recovered when double the amount was applied is doubtless due to the timothy having reached its limit of possible growth under the conditions, since much of the timothy on the plat receiving 640 lbs. nitrate of soda became lodged on account of its rank growth. It is, of course, easy to assert that the nitrogen in the plants did not come from the nitrogen in the nitrate of soda, but that the nitrate of soda had some indirect influence. Since no one has shown such indirect influence on the part of nitrate of soda, it is much simpler and a great deal more convincing to assume the direct influence of nitrate of soda as a plant food. If this is admitted we must then admit that this soil did not contain enough plant food in available form and at the right time to grow a maximum crop of timothy.

The experiment further indicates that the timothy consumed most of the plant-food available. It is unfortunate that we did not have determination of the water-soluble nitrogen immediately before and immediately after applying the nitrate of soda. However, on this same type of soil in another experiment where 320 pounds of nitrate of soda were applied to the new seeding of timothy and where but little vegetation was produced the average amount of NO_3 in four determinations May 22, June 5, June 25 and July 16, was 58.8 parts per million. Omitting July 16, the average of three determinations was 69.8 parts per million.

Since not all of the nitrogen applied was recovered, the question may be raised as to what became of the rest of the nitrogen. Let us suppose that 58.8 parts of NO_3 per million of dry soil became soluble when we

applied 320 lbs. of nitrate of soda or 50 pounds of nitrogen and that at harvest there was 2.5 parts of NO_3 left in the soil: thus for argument merely it will be assumed that 56.3 parts of NO_3 per million of dry soil was taken up by the plant. This is only 13 pounds of nitrogen per million of dry soil. We would have to assume, therefore, that all the water-soluble nitrogen in 3 to 4 million pounds of soil was found and used by the plant.

Probably no such thing occurs in the soil. When nitrate of soda is added to the soil, as repeatedly shown in the investigations at this station and elsewhere, part of the nitrogen is fixed in the soil and a part of it goes into solution. What probably happens is that as the soil is exhausted of its water-soluble nitrogen by the plant, a part of this fixed nitrogen goes into solution. The behavior of nitrate of soda when applied to soils strongly indicates this action. What probably happens is that when nitrate of soda is applied more nitrogen keeps going into solution at just the time when the plant is making great demands on the soil for this nitrogen than when nitrate of soda is not added. Thus having water-soluble nitrogen on tap at the right hour and the right place is *one* of the factors that enabled the Cornell Station to grow three and one-half tons of timothy hay on Dunkirk clay loam when without this artificial help only about one and one-half tons could be raised.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO THOSE RESIDENTS OF NEW YORK STATE WHO MAY DESIRE THEM.

93 The Cigar-Case-Bearer.
121 Suggestions for Planting Shrubbery.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
134 Strawberries Under Glass.
135 Forage Crops.
136 Chrysanthemums.
137 Agricultural Extension Work, Sketch of Its Origin and Progress.
139 Third Report upon Japanese Plums.
140 Second Report upon Potato Culture.
141 Powdered Soap as a Cause of Death among Swill-Fed Hogs.
142 The Codling-Moth.
143 Sugar-Beet Investigations.
144 Suggestions on Spraying and on the San José Scale.
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245 Spray Calendar.

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BULLETIN 248 JULY, 1907

CORNELL UNIVERSITY

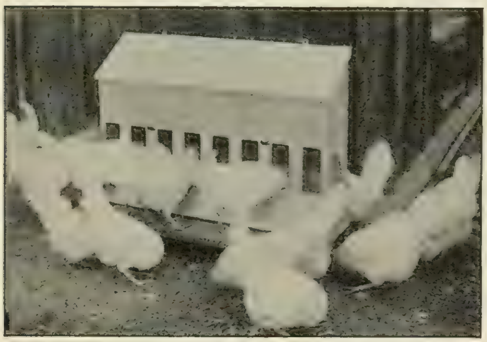
AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Animal Husbandry (Poultry Husbandry)

(EXTENSION WORK)

NEW POULTRY APPLIANCES



By JAMES E. RICE and R. C. LAWRY

ITHACA, N. Y.

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ORGANIZATION

Of the Cornell University Agricultural Experiment Station.

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

Modern poultry husbandry demands improvements in three principal directions. The first has to do with economy of labor; the second is concerned with better sanitary conditions; the third calls for fowls with greater vigor and higher laying capacity. Large expense for labor, heavy loss from disease, and low average egg-laying capacity per fowl, are three existing handicaps to the most profitable poultry farming.

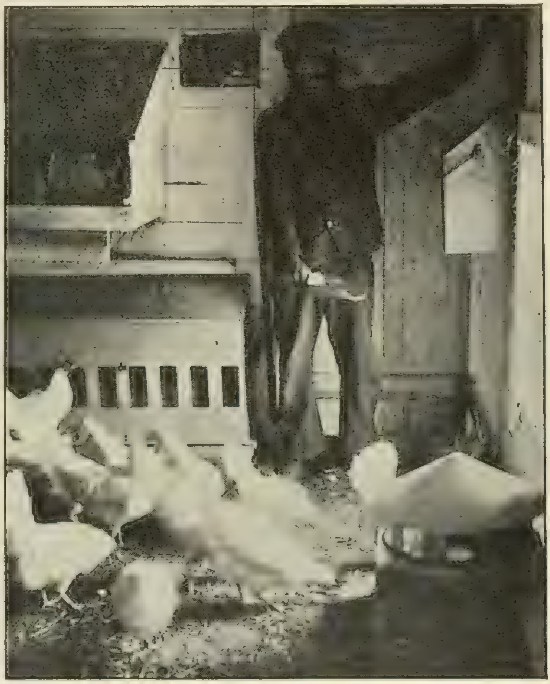

Fig. 86.—*Feeding with the hand scoop; the New York trap-nest on the wall; the feed hopper underneath. The feed supply can to the right. Sanitary water pan and grit hopper in fore-ground.*

This bulletin describes a few ways and means for saving labor, preventing disease and increasing prolificacy. The thirteen appliances here mentioned originated at this station and are now in practical operation. They are unpatented and are given to the public by the New York State College of Agriculture at Cornell University. So far as we know, they are not infringements on existing patents. Manufacturers and others are at liberty to use these devices, but the college will not be responsible for litigation that may arise from alleged infringement.

The appliances that are here described are as follows:

1. A New Trap-Nest, page 208.
2. A Non-Wasting Rat-Proof Feed-Hopper, page 214.
3. A Force-Feed Grit-Hopper, page 217.
4. A Feed Supply-Can, page 218.
5. An Egg Distributing-Table, page 219.
6. An Egg Carrying-Box, page 220.
7. A System for Keeping Laying Records, page 221.
8. A Combination Crate for Eggs and Dressed Poultry, page 221.
9. A Sanitary Water-Pan, page 225.
10. A Device for Carrying Kerosene Oil to Incubator Cellar, page 225.
11. A Catching-Hook, page 226.

12. A Chick Feed-Trough, page 226.
13. A Cover for Water-Pan, page 227.
14. A Removable Floor for Chicken-Shelter, page 228.

I. AN IMPROVED TRAP-NEST.

Invented by R. C. LAWRY.

During the past three years the college has been experimenting with trap-nests with the view to finding one that would be inexpensive to install, easy to operate, and that would be dependable. In all, six different types of nests were tested. Three were manufactured nests and the other three were inventions of the college. One of the latter devices is here described.

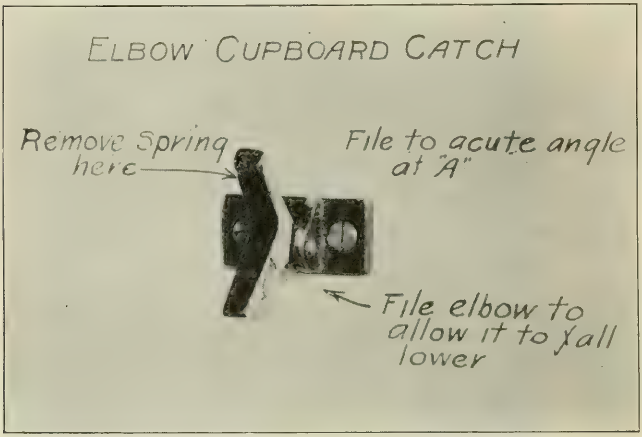

FIG. 87.—*The simple catch that locks the trap.*

The main difficulty has been to get a nest that would be sure to work, would not catch more than one hen at a time and that would be practicable to use on a large scale. Some of the nests were good, but were so large and cumbersome that it did not pay to operate them or to give them the necessary room in the poultry house.

FIG. 88.—*The New York feed-hopper closed. Note the wire mesh at end which furnishes light.*

Plates I and II illustrate the improved New York trap-nest which the Department is using at present. This nest costs but little more to build than the ordinary nest boxes and can be used singly or run along in series, either under the droppings board or fastened to the wall. Plate I shows

the nest installed underneath the droppings board. Plate II shows it in use on the wall. The wall form is preferred and has been tried with and without the hinged top. It would seem that the hinged top serves little purpose other than to facilitate cleaning and replenishing the nest with straw, because the hens come to the front of the nest after they have laid and will readily walk out when the trap is opened. (Plate II, Fig. 2.) This nest is very simple to operate. The fact that the trap in front is closed, shows the attendant that there is a hen in the nest. (Plate II, Fig. 4.) When he removes the hen, he has reset the nest. The trap being made of galvanized iron, does not offer a very inviting place for the hens to loaf, and so does away almost entirely with the possibility of more than one hen entering the nest. (Plate II, Fig. 1.)

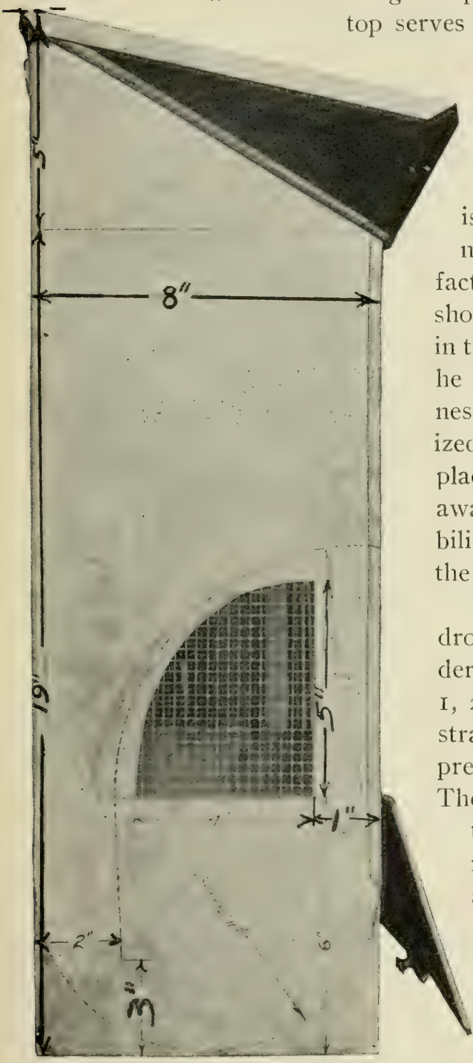

Fig. 89. — *End view of feed-hopper. Note curved bottom and front which insures a positive force feed.*

When the nests are put under the droppings board, the floor comes under the nest part only. (Plate I, Fig. 1, 2, 3 and 4.) This is to keep any straw from getting under the trap and preventing it from working easily. The nests are built in sections without top or bottom and are slid in underneath the trap parts, much on the same principle as a table drawer. (Plate I, Fig. 3.)

The wall nests are placed on brackets or are screwed to the wall through the back of the nests. The tops are made slanting to prevent the fowls from roosting on them. The bottoms are made of one-half inch mesh galvanized hardware cloth which goes under the nest parts only, the end sought being a nest with as few places as possible for mites to breed and that is self-cleaning. This is an experiment that is giving very satisfactory results.

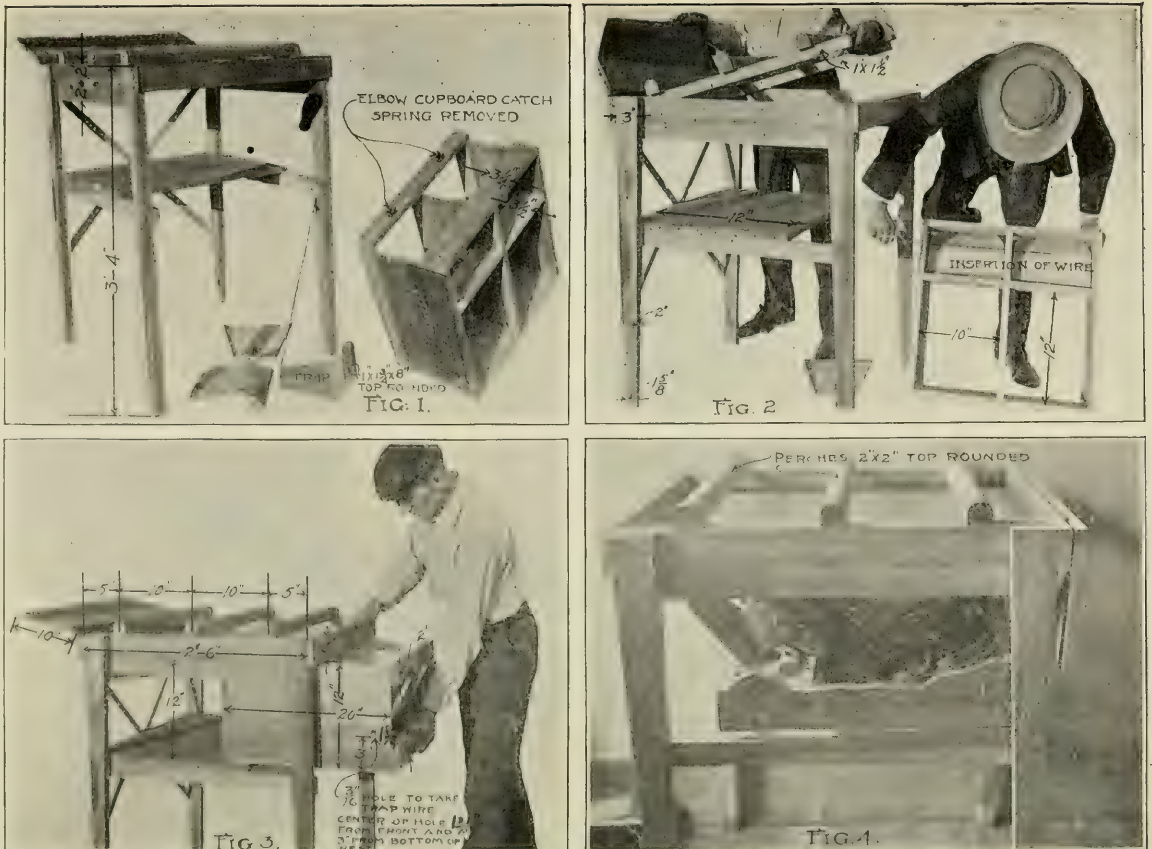

PLATE I.—*Four views of the Improved New York trap-nest placed under the roosting device. Fig. 1 shows the nest removed; Fig 2 the method of placing axle wire and also of removing the perches; Fig. 3 the drawer principle of placing the nest; and Fig. 4 the nesting and roosting arrangement complete with a hen entering the nest.*

The dimensions given for the nests (Plates I and II) are for Leghorn fowls. To use these nests with larger breeds, it would be necessary only to widen the opening at the entrance (Plate II, Fig. 4) one inch and to lengthen the front of the trap (Plate II, Fig. 4 B) one inch.

The successful operation of these nests depends largely on the catch shown in the accompanying cut. (Fig. 87.) The device used is an ordinary elbow cupboard catch that should not cost more than 30 cents a dozen and needs only to have the spring removed and to be filed slightly at the points indicated, before it is ready for use. One nest should be provided for every four or five hens.

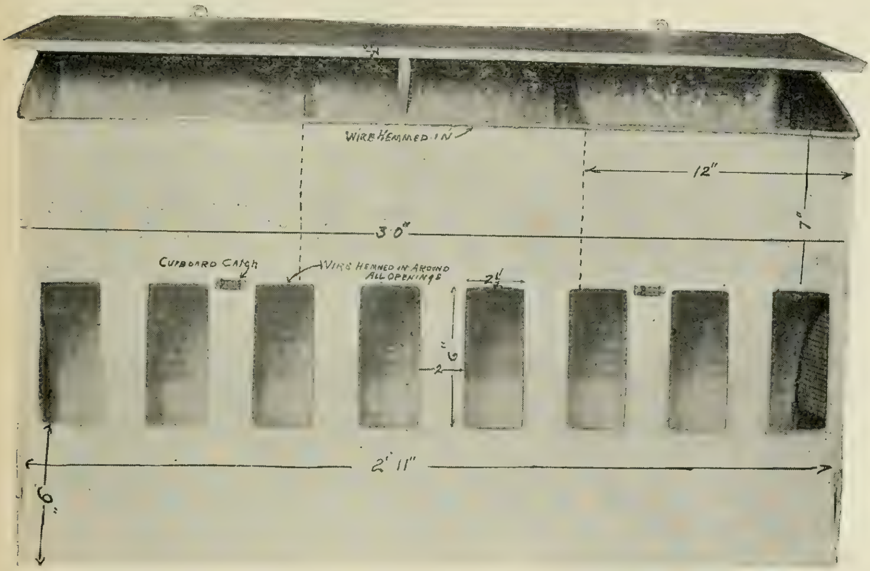

FIG. 90.—*Front view of the feed-hopper Note that the fowls must reach down for the feed.*

It is not recommended that trap-nests be used by the general farmer or poultryman, except in special instances. Trap-nests, however, are indispensable for investigational and instructional purposes, and for persons who desire to sell pedigreed stock and eggs for hatching.

The labor involved in collecting the eggs many times a day, keeping the records of each hen, hatching with pedigree trays, toe-marking and leg-banding the chickens, requires more exacting work and close attention to detail than most poultrymen at the present time would care to undertake, even though the reward may be great in the building up of a strain of heavy producers.

For the poultryman or farmer who does not care to sell pedigreed stock but who desires to increase the laying capacity of his fowls by

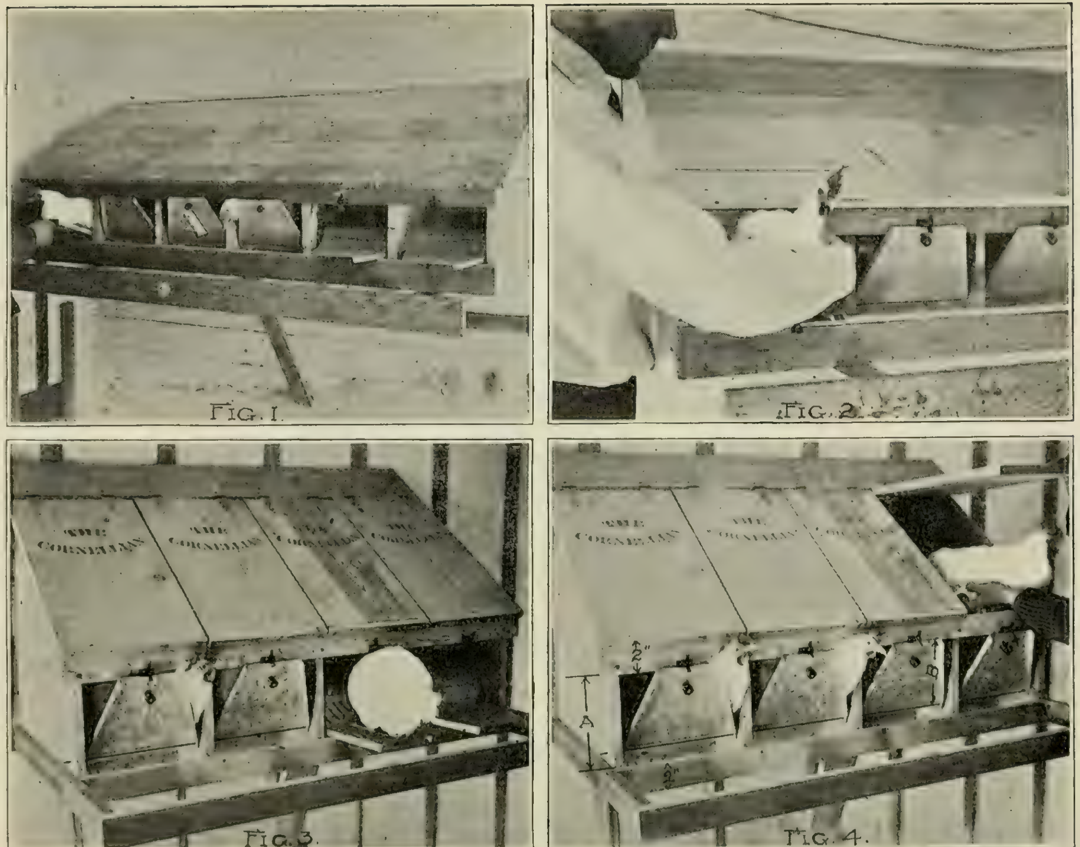

PLATE II.—*Four views of the Improved New York trap-nest placed on a wall bracket. Fig.* 1 *shows nests both open and closed with hen ready to be released; Fig.* 2, *method of removal of hen; Fig.* 3, *how the hen enters the trap; Fig.* 4, *the incline cover lifted for removal of hen or for cleaning.*

breeding from the most productive, the plan is suggested of trap-nesting each year the choicest pullets for the first six months or more of their first laying year. From these select the most productive pullets to be used as breeders the following year, that is, when they are two years old from the shell. It has been found that pullets show early in life their egg-laying capacity, so much so that pullets of the same age and variety given similar care, that lay the largest number of eggs during their first year from the egg, will, in all probability, be the most prolific individuals in the flock. This method will do away with the necessity

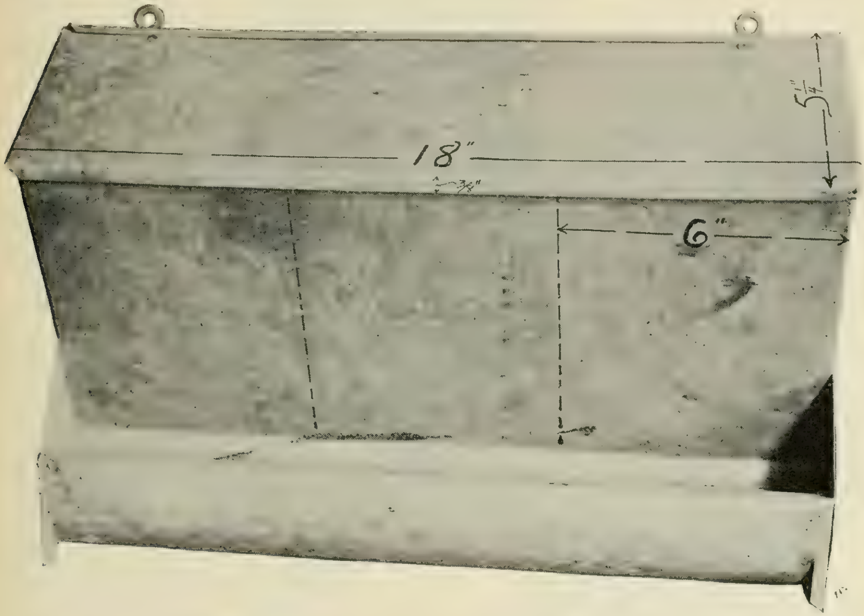

Fig. 91. —*The new force-feed grit-hopper with three compartments. Note slanting top and method of attaching to the wall.*

of trap-nesting the entire year and will permit the record-making to be done during the six months, approximately, October, November, December, January, February and March, when the time can best be spared on a general, or on a poultry farm.

For the poultryman, however, who is adapted to the work and who will trap-nest conscientiously and continuously and who will breed intelligently, we think there is large reward. The reward will come first by increasing the yield per hen and thereby the profits for commercial egg production, and second by the production of pedigreed stock for breeding purposes and eggs for hatching. The latter will require in addition to the special knowledge of how to feed, house, trap-nest and to breed poultry in order to secure large production and vigorous stock, a

special training and adaptability in selling in order to place the product before the buying public. This means skillful advertising. It will require time and skill, but we think that it will pay both in financial reward and in the satisfaction of having contributed something toward the upbuilding of a superior strain of poultry and setting a notch higher the standard of perfection in egg production. The trap nest has an intellectual as well as a financial incentive.

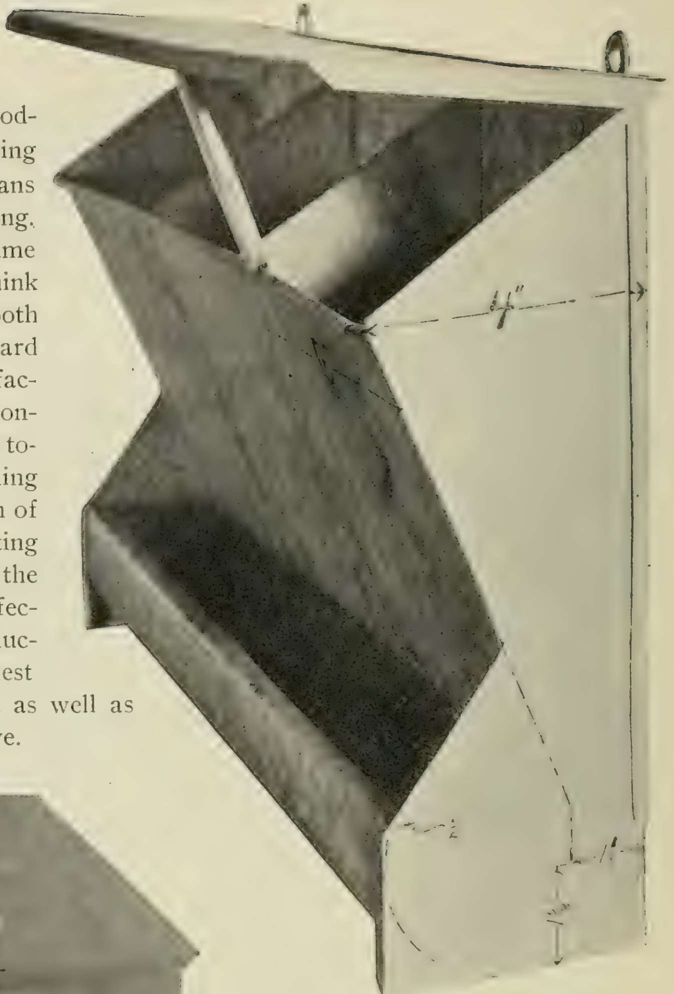

FIG. 92.—*The grit-hopper. Observe the rounded back overhanging lip in front to prevent waste.*

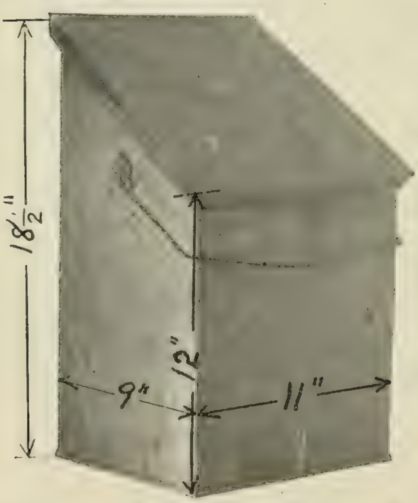

FIG. 93.—*A feed-supply can out of reach of rats and handy for feeding. Holds 25 pounds whole grain.*

The traps are made for the Station in two sizes, large and small, by L. R. Lewis, Cortland, N. Y., and Treman, King & Co., Ithaca, N. Y. They are made of No. 24 galvanized iron. They should not cost more than $1.75 a dozen.

A FEED-HOPPER FOR POULTRY.

Invented by R. C. Lawry and James E. Rice.

It now seems certain that hopper-feeding in some form is to be an important part of the modern system of poultry-feeding. Hopper-feeding saves labor, guards against under-feeding and makes the keeping of fowls in large flocks less objectionable because it avoids crowding, which is likely to occur when fowls in large flocks are fed a wet mash. Experiments which have been conducted at this station indicate that for young fowls of the laying varieties, kept for commercial egg production, the feeding of a dry mash in a feed-hopper which is accessible at all times

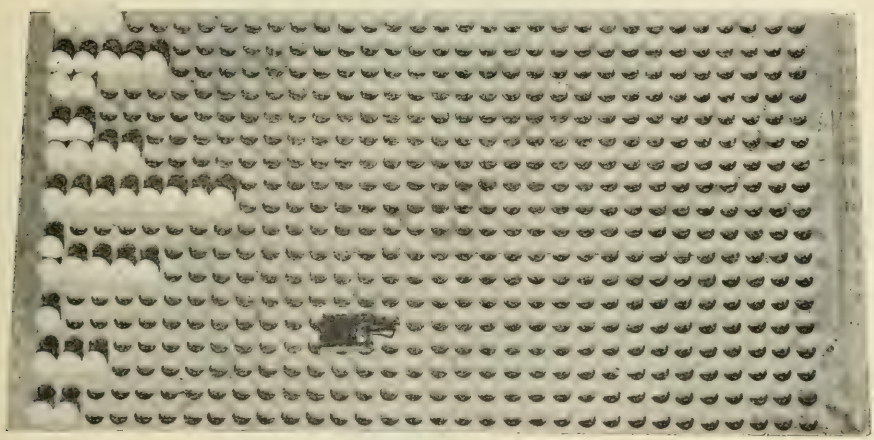

Fig. 94.—*The egg distributing-board. Observe the ease with which eggs can be classified. Numbers* 1, 2, 3, *etc., from left to right, placed at each egg, will show how many eggs are laid that day from each pen without the necessity of counting.*

during the day, is to be recommended. Whether the same system of feeding will prove as satisfactory with old fowls of the laying varieties or with young fowls of the general-purpose or meat varieties, we have not yet determined by actual comparative test. Nor has it been proved that the system can be used with safety with breeding fowls. This is a vital consideration. The ultimate test which will decide whether or not the hopper-feeding of dry mash will be of universal application to the feeding of fowls, will be the effect on the vigor of the offspring. It is too early yet to decide this point. Many practical feeders, however, conclude from an extended experience, that the breeding fowls having constant access to dry mash, will not suffer in health from over-eating or lack of exercise.

We feel certain at this time that hopper-feeding when properly employed has genuine merit and will become an established practice. To be successful, however, it must be adapted to suit the various breeds and other conditions as to age, season and environment.

FIG. 95.—*The egg distributing-table.*

In figures 88, 89, 90 and cover piece, are shown a feed-hopper which is used for feeding dry meals, meat scraps or grain. It is made of No. 26 galvanized iron, is 36 inches long, 24 inches tall and eight inches wide, divided into three compartments 12 inches wide and will hold about 60 pounds of meal or 100 pounds of grain. It is built with a slanting

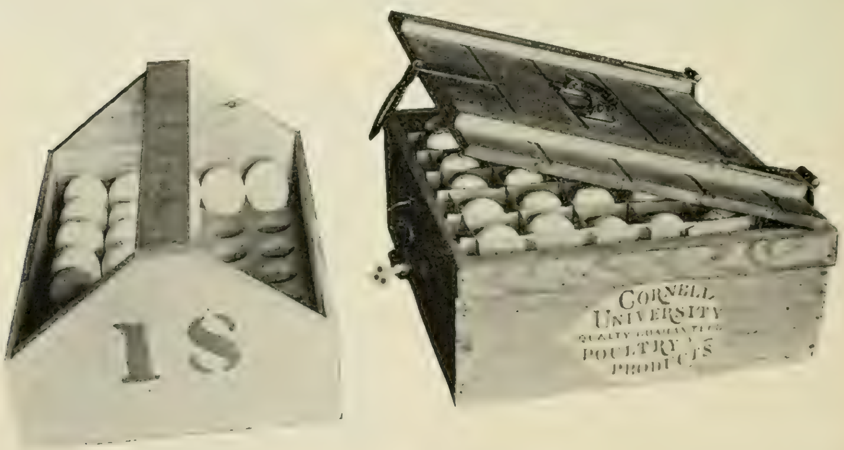

FIG. 96.—*The carrying-box and a six dozen egg-case for private trade. Note the handle, also the Poultry Department stencil—a white egg with lettering in red, (which makes the Cornell colors.)*

top and has a door on the front that hinges up from below to close the opening when it is desired that the fowls should not eat. It is the outcome of a long series of experiments and is the only hopper of a large number tried at the station plant that will not waste feed and yet does not clog. The fact that it has a door to close and that it is made of galvanized iron, makes it entirely rat-proof. It is placed on a platform five inches tall that projects outward six inches in front tc prevent the litter from being scratched into it. It has been found that one catch in the center of the door is more satisfactory than the two catches as shown in the illustration. The cost is about $4.

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NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY.
DEPARTMENT OF POULTRY HUSBANDRY.
Weekly Report.

25

Weight.						Daily Egg Record. Mar.									Days Lost.			Broody.		Remarks
Hen	Past	Pres.	Gain	Loss	Bro't Fwd.	23	24	25	26	27	28	29	Total Laid	Car. Fwd.	Mortality	Removed	Days Lost	No. Br.	Br. Days	As to Moult, etc.
56	3.9	3.8		.1	175			56		56		56	3	178						
57	3.2	2.8		.4	132	57		57	57		57		4	136						
58	3.5	3.9	.4		128			58		58		58	3	13.						
59	4.0	3.8		.2	120		59		59		59		3	123						
60	3.9	4.0	.1		132				60	60		60	3	135						
61	3.4	3.5	.1		228	61		61	61		61	61	5	233						
62	2.9	3.0	.1		122									122						
66	3.8	3.6		.2	111	66		66					2	113				3.25.7	2	
67	3.0	3.3	.3		125	67					67		2	127						
68	3.0	3.5	.5		124	68	68		68	68			4	128						
69	3.4	3.6	.2		171				69		69		2	173						
70	4.0	3.4		.6	190	70		70			70		3	193						
73	3.2	3.3	.1		125		73		73		73		3	128						
75	3.6	3.3		.3	143		75		75		75		3	146						
76	3.5	3.3		.2	120	76	76		76	76	76		5	125						
77	3.1	3.1			163		77		77				2	165						
83	4.0	4.3	.3		102	83	83		83		83	83	5	107						
84	3.0	3.1	.1		88		84	84		84	84		4	92						
85	3.5	3.5			184		85	85	85		85	85	5	189						
87	3.7	3.8	.1		155	87	87		87	87		87	5	160						
90	2.8	3.1	.3		154			90	90		90	90	4	158						
103	3.1	—		-	88									88	3.25.7			E 5		See mortality Rec. 11
110	3.7	3.7	.1		86				110			110	2	88						
113	4.5	4.4		.1	120	113		113		113		113	4	124						
114	3.9	3.8		.1	101		114		114			114	3	104						
115	4.4	3.7		.7	107	115		115	115			115	4	111						
117	3.6	3.4		.2	140	117		117		117		117	4	144						
120	4.1	3.7		.4	136			120	120		120		3	139						
121	4.7	4.7			88	121	121		121		121		4	92						
129	3.0	3.6	.6		80									80						
M	6.2	6.3	.1																	

totals
30 110.5 110.4 3.4 3.5

FIG. 97.—*The method of keeping trap-nest records. Note record of hen No. 61 at 14 months.*

A FORCE-FEED GRIT-HOPPER.

Invented by JAMES E. RICE and R. C. LAWRY.

Recent experiments at the college have proved that both lime and grinding material are required by fowls for best results in health and production. It is essential, therefore, that fowls have access to cracked oyster shells at all times. It also appears to be desirable that some other form of grit be provided, and perhaps charcoal. For this purpose a grit-hopper large enough to make frequent filling unnecessary, so constructed that it will be kept clean, cannot clog or waste, is necessary. The grit-hopper here shown accomplishes the above results. (Figs. 91 and 92.) Its distinguishing feature is the rounded back which compels a forced-feed. (Fig. 92.) The cost should not exceed $1.

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Weekly Report.

Experiment No. 27-3 Problem The Influence of the Productive Parent on the Vitality of the Offspring
Pen No. 25 Variety White Leghorns No. of Males 1 Age 2 No. of Females 29 2/7 Age 2 Total 30 2/7
Period No. 33 Date from March 23 to 29 1907 In charge of C. A. Rogers

Date.	Eggs Laid	Corn	Crac'd Corn	Wheat	Oats	Buck Wh.	Corn Meal	Wh. Bran	Wh. Mids.	Gr. Oats.	Alf. Meal	Meat Scr.	Gr. Cut Bone	Roots	Oyst. Shell	Grit	Litter	Dust Bath	Water	Manure	Misc.	Misc.	Morning Temp. Out	In
March																								
23	14		165	1.65	1.10	1.10	1.13	.69	1.13	.25	.14	1.13				.5								
24	12		6.0	6.0	4.0	4.0									5.0	5.0								
25	13																							
26	19		6.0	6.0	4.0																			
27	10						5.0	3.0	4.0	1.0	.5	4.0												
28	17		6.0	6.0	4.0									4.0										
29	14																							
Total	99		19.65	19.65	13.10	5.10	6.13	3.69	5.13	1.28	.64	5.13		4.0	5.0	5.5								
Weighed Back			6.0	6.0	4.0	'	3.70	2.21	2.99	.74	.37	2.99			2.3	5.4								
Am't Consumed			13.65	13.65	9.10	5.10	2.43	1.48	2.14	.54	.27	2.14		4.0	2.7	.1								
Price	.22		1.20	1.75	1.30	1.20	1.25	1.20	1.30	2.00	1.60	2.25		.25	.50	.60								
Value	1.515		.159	.239	.118	.061	.031	.018	.028	.011	.009	.045		01	013	.001								
Am't bro't f'd	1334		368.5	251.43	275.26	53.90	85.10	56.04	82.21	10.76	27.31	44.29	9.2	51	39.3	44.3								
Total Am't car. f'd	1433		391.70	295.05	284.36	59.00	87.53	57.52	84.35	10.30	27.58	46.43	9.2	55.	42.	44.4								
Value bro't f'd	3344		4527	3.922	3.577	.635	1.059	.669	1.068	.214	.432	1.039	.164	.126	.178	.266								
Total Val. car. f'd	35255		4.091	4.161	3.695	.699	1.090	.687	1.096	.225	.436	1.086	.164	.136	.211	.266								

Time Acct.	A.M.	M.	P.M.	A.M.	M.	P.M.	A.M.	M.	P.M.	A.M.	M.	P.M.	A.M.	M.	P.M.	A.M.	M.	P.M.	A.M.	M.	P.M.	Total
Commenced	8.20	12.15	4.45	8.50	1.00	4.30	8.30	12.15	5.05	8.00	12.15	4.15	8.15	12.15	4.15	8.15	12.15	4.30	8.50	1.00	4.30	
Stopped	6.30	12.25	4.55	9.00	1.15	4.40	8.45	12.30	5.15	8.15	12.25	4.25	8.30	12.30	4.25	8.30	12.25	4.45	9.00	1.15	4.40	
Total Min.	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.55
Price pr. M. .0025c.																						
Total	.025	.025	.025	.025	.0375	.025	.0375	.0375	.025	.0375	.025	.025	.0375	.0375	.025	.0375	.025	.0375	.025	.0375	.025	.06375

SUMMARY.

Total cost of food =	17.598	.736	18.634	Total value of eggs =	33.440	1.815	35.255
Total cost of labor =	not considered			Total value of manure =	not computed		
Total cost of litter =	not computed			Total value of litter =	not computed		
Total cost loss of stock =	.936	558	1494	Total value of stock sold	none		
Total cost loss in weight =	none			Total value of gain in weight	2.342		2.342
Total outgo =	1853	1294	20.128	Total value of income	35.782	1815	37597
Balance profit =	469			Balance loss			
Brought forward =				Brought forward			
Carried forward =				Carried forward			

FIG. 98.—*The profit and loss record.*

A FEED SUPPLY-CAN.

Planned by JAMES E. RICE.

One of the ways in which labor can be saved is to have each pen equipped with a feed-box large enough to hold a week's supply of whole grain. (Fig. 93.) These can be filled once a week more easily than the same quantity of grain can be carried about the entire plant in a basket twice a day when feeding the hens by hand. By the feed supply-can system the attendant carries only a small hand scoop from pen to pen when feeding. (Frontispiece.) He is then free to carry only one basket when gathering the eggs. When feed supply-cans are not used, the eggs are gathered and the last grain-feeding is done at the same time, or it becomes necessary to make an extra trip through the pens to gather the eggs after feeding the fowls. It is a decided advantage to be relieved of carrying both feed-basket and egg-basket at one time.

The supply-can also provides a convenient place to put the eggs when they are removed from the nests during the day if trap-nests are used and, therefore, must be looked after frequently. The cans should not cost to exceed 90 cents.

AN EGG DISTRIBUTING-TABLE.

Planned by JAMES E. RICE.

Persons who are using many trap-nests and, therefore, have occasion to keep records of the eggs, will find the distributing-table here shown (Figs. 94 and 95) a great convenience in arranging the eggs in systematic order for recording and for placing in pedigree trays.

This table may be made of one-inch or thicker lumber which will not warp. It is well to put the top together with a glued and doweled joint.

The table top may be made by itself and placed on an ordinary table for support (Fig. 94), or may be made as a permanent table with stationary top. (Fig. 95.)

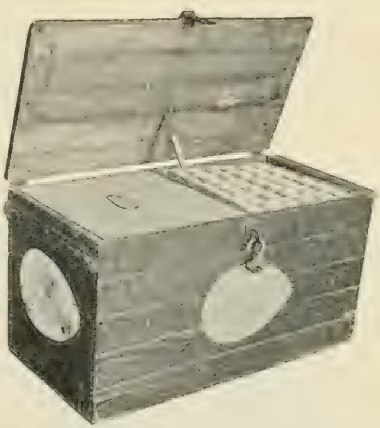

FIG. 99.—*The combination - crate ready to close for shipment. A strawboard filler partition is placed over the eggs before closing.*

A table 69 inches by 37 inches is large enough to hold the eggs from 18 pens, containing about 50 hens each. The table holds 32 eggs from each pen.

If the flocks contain more than 50 fowls, a longer table must be made. If more pens than 18 are to be recorded, an additional table will be necessary. The table here described cannot be made wider without making it inconvenient to use, owing to the difficulty in reaching across a wider table.

The wells which receive the eggs should be two inches apart from center to center and should be bored one inch and three-eighths in diameter, one-half inch deep. In order to let the small end of the egg rest firmly in the opening, the well should be sunk ¼ of an inch deeper with a ⅞ inch bit.

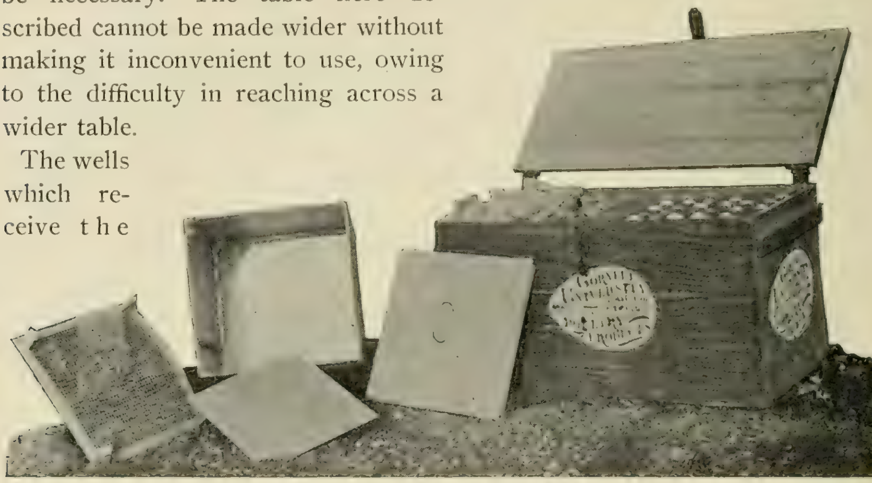

FIG. 100.—*The combination-crate filled with eggs and dressed poultry; also the parts of the refrigerator box.*

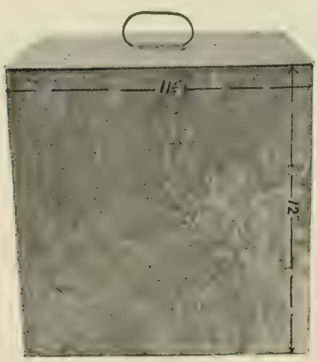

FIG. 101.—*The refrigerator-box for the combination-crate.*

AN EGG CARRYING-BOX.

Planned by JAMES E. RICE.

When trap-nests are used with a large number of pens, it sometimes is desirable to keep a carrying-box for each pen (Fig. 96) which receives the eggs as they are gathered. At night the carrying-boxes are assembled at the egg room and recorded. The wells in the bottom of the box are the same size as in the distributing-table and hold the eggs in an upright position on the little end, where the numbers can be easily read. This system is indispensable when instruction is given to a large number of students, each having a different pen.

Method of Marking the Eggs.

In order to use the egg distributing-table to the very best advantage, the eggs should always be marked when they are removed from the nests. A uniform system of marking them should be adopted. The method which we follow is to place the number of the hen and the number of the pen on the large end of the egg thus: $\frac{145}{\text{P. 1}}$ hen number 145 and pen number 1. All the eggs each day can then be arranged on the distributing-table, little end down, in the order of the pens, 1, 2, 3, 4, etc., across the table, and also in the order of the leg-band number of the hens in each pen from left to right: that is, pen number 1, hen number 145, 146, 147, etc. (Fig. 94.) All the numbers can then be seen quickly at a glance and may be transferred to the records in systematic order.

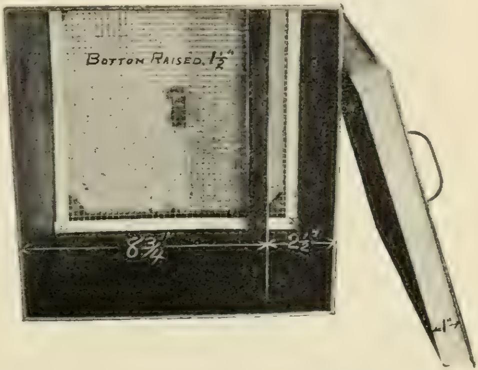

Fig. 102.—*View inside the refrigerator-box showing the ice-chamber and the false bottom for drainage.*

A SYSTEM FOR KEEPING TRAP-NEST RECORDS.

Planned by James E. Rice and R. C. Lawry.

A workable system for keeping the records of each fowl as to egg production, date, broodiness, sickness, death, etc., is a necessity when

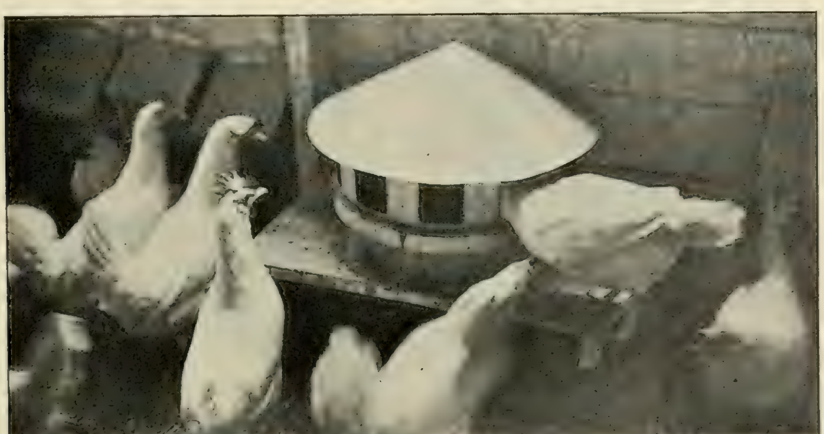

Fig. 103.—*The sanitary water-pan and cover in use. Note platform 10 inches above the floor.*

trap-nests are to be used successfully. Much of the success and satisfaction to be derived from trap-nests will depend on the system adopted in keeping the records. They must provide for accuracy, simplicity and accessibility. They should show at all times the total egg yield of each fowl. This not only saves labor but adds greater interest to the work.

The accompanying illustration of an actual record sheet is offered for the purpose. (Figs. 97 and 98.)

The record-sheet here shown is for instructional and investigational work which is best arranged for periods of one week. For commercial use it is preferable to arrange the sheets for periods of one month each, otherwise retaining the same general arrangement.

In Fig. 98 is shown the reverse side of the trap-nest record which provides for keeping a profit and loss account of food consumed, cost for labor, income, etc. This is intended primarily for the instruction of students, but can be used in part and adapted for use on commercial plants.

A COMBINATION-CRATE FOR EGGS AND DRESSED POULTRY.

Planned by JAMES E. RICE.

There is a growing demand for wholesome, fresh eggs, and for better quality of properly fattened poultry than is to be found regularly in the market. Coupled with the desire for better poultry products, is a belief that these articles can be secured most satisfactorily direct from the producer. A good business opening, therefore, is presented for poultrymen, who desire to cater to one of the best paying and most satisfactory trades—the private family trade.

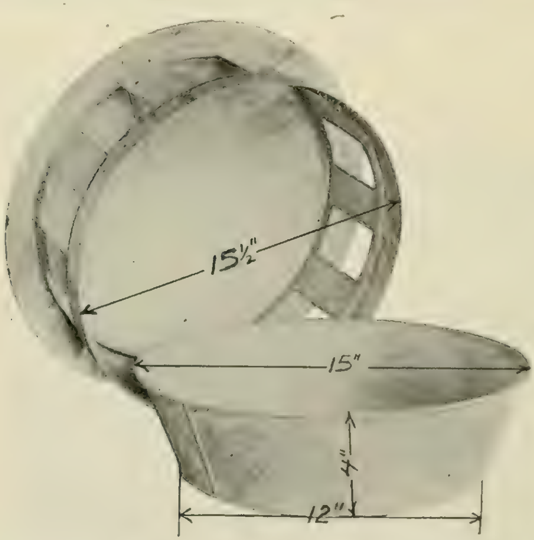

FIG. 104.—*The sanitary water-pan uncovered. Note flanged rim of cover.*

One of the difficulties in supplying a private trade has been to secure a strong, attractive, ser-

viceable crate that would carry dressed poultry with safety during hot weather.

The type of crate here shown (Figs. 99, 100, 101 and 102) has been used for several years to ship both eggs and dressed poultry several hundred miles by two express companies during the hot summer months. Both eggs and dressed poultry have been carried in the same crate in perfect order.

The advantage of a crate which can be used for both eggs and dressed poultry, or for either poultry or eggs alone, is apparent. The producer is enabled to supply each customer with both poultry and eggs instead of either one alone. It is of equal advantage to the consumer to be able to secure his or her poultry and eggs direct from the farm.

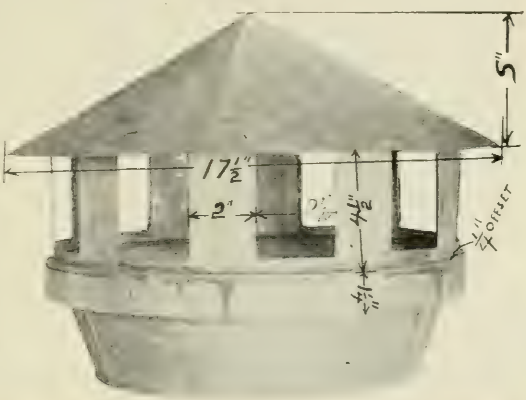

FIG. 105.—*The sanitary water-pan, showing the small space open for entrance of liter.*

The profit is considerable when the prices secured from a good private trade are compared with wholesale prices for similar products sold in the same city. The consumer not only is willing to pay the highest retail store price for poultry products shipped direct from the farm, but frequently will pay (after his taste has been educated) a large premium on account of the superior quality and regularity of supply. The retail store price for the best eggs in the large cities is five cents to twenty cents per dozen above the wholesale quotation for similar eggs. There is about the same difference in the price per pound for the best dressed poultry. If the difference be 10 cents per dozen for eggs or 10 cents per pound for poultry and the egg yield per hen be estimated at ten dozen marketable eggs per year and the dressed weight of a fowl be five

FIG. 106.—*The oil barrel in position. The astral oil gives better results than the standard* 150 *test.*

pounds, the difference in price received for the eggs is $1 per hen per year and for the fowl, 50 cents. The same rule would apply to the selling of squabs, turkeys, guineas, ducks, broilers, fryers, roasters, etc. Out of this might come the express charges which usually will amount to about three to five cents per dozen or per pound, depending on the distance from market and the number of dozen of eggs or pounds of poultry shipped. The price per crate is the same whether it contains six dozen or thirty dozen. Therefore, the larger the shipment, the less the cost per dozen. Usually, however, the consumer pays the express charges.

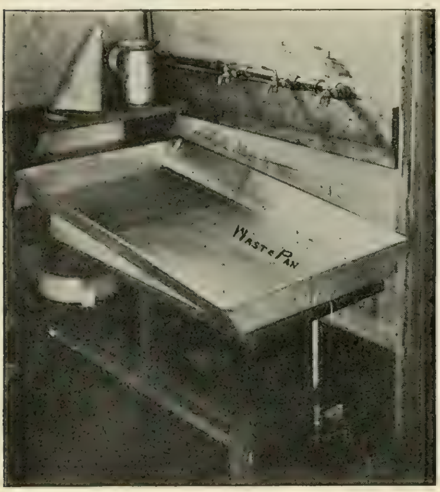

FIG. 107.—*The interior arrangement for draining oil. Note edge of table at left for cleaning and trimming lamps.*

The crate may be made of three-eighths inch Georgia pine ceiling finished in the natural wood, which makes an attractive appearance. The Georgia pine, however, splits easily and the crates will not prove as durable as they would if made of white-wood. They are made of the same size and shape as the common thirty-dozen commercial egg-cases. In fact the ends, the partitions and the bottom, if care is used in selecting the best, may be used by simply replacing the sides and tops with Georgia pine or white-wood.

The refrigerator-box is made of number 26 galvanized iron and fits into either compartment of a thirty-dozen case. It is, therefore, $11\frac{1}{4}$ inches square, outside measure, and 12 inches high, with a cover that fits tight inside with a flange like a dinner pail. A false bottom $\frac{1}{4}$ inch mesh wire cloth, $1\frac{1}{2}$ inch from the floor, provides drainage and prevents the poultry from resting in the water formed by the melting ice. (Figs. 100 and 102.) A removable partition of heavy galvanized iron fits in the slots on the inside of the refrigerator-box to form a compartment three inches wide which holds the ice. The refrigerator-box holds about 25 pounds dressed poultry and about six to eight pounds cracked ice. Poultry should be thoroughly chilled before packing.

Each crate should be neatly stencilled, giving the name of the farm and the owner, shipping station and contents of crate. This makes the crate more attractive, advertises the farm, and insures safer handling

and surer return of the crate. A small padlock adds to the attractiveness and also to the safety of the package. Cost about $2.25.

For shipping eggs, only, to private customers, smaller crates may be made, holding multiples of three dozen each, that is, three dozen, twelve dozen, fifteen dozen, etc. (Fig. 96.) Common three-dozen pasteboard fillers are used. The cost complete should not exceed 50 cents or 75 cents each for the smaller-sized crates.

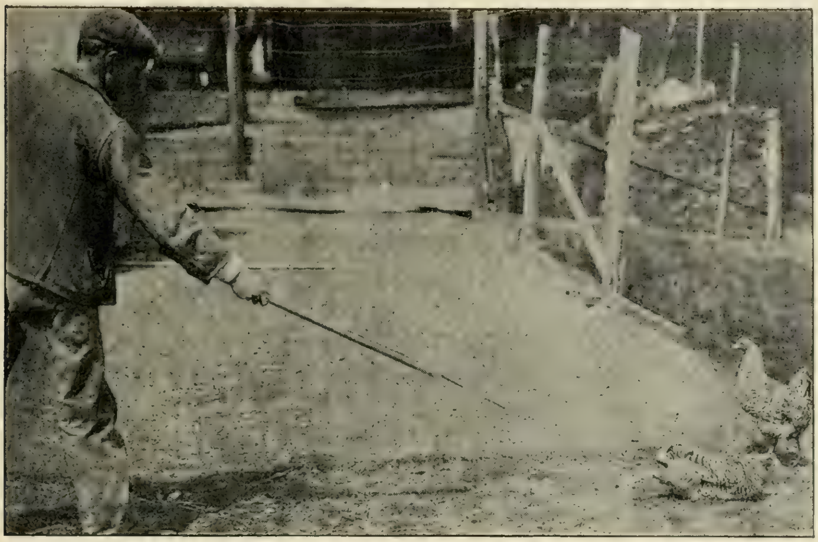

FIG. 108.—*The catching-hook in use.*

A SANITARY WATER-PAN.

Invented by R. C. LAWRY.

Clean water is very desirable in the production of sanitary poultry products. It is important, therefore, to have a watering device which will keep the water-pan as free as possible from the dust and litter of the house and droppings from the fowls. A water device must be easily filled and cleaned if it is to be of practical use. The water-pan here shown meets the above requirements in a satisfactory manner. (Figs. 103, 104 and 105.) The round, deep pan with flaring sides, is more easily emptied without injury to the pan in case of hard freezing. It presents a comparatively small surface to catch dust and dirt. The round, cone-shaped top prevents the fowls from roosting upon it. The openings in the side walls permit the fowls to drink from different sides at one time, and presents the smallest possible amount of opening for dust and litter to enter. The platform on which it stands, being 10

inches from the floor, is high enough to prevent the litter being scratched into it. It is found that where water pans are placed much higher than this, fowls do not drink as much water.

The water-pan and cover is made of No. 26 galvanized iron. It should not cost to exceed $1.40.

FIG. 109.—*Detail of catching-hook. Note method of fastening wire to handle.*

A METHOD OF CONVEYING KEROSENE OIL TO INCUBATOR CELLAR.

Planned by R. C. LAWRY and JAMES E. RICE.

There is considerable labor involved in carrying oil in a five-gallon can from a barrel outdoors to the incubator cellar, where many incubators are operated. To obviate this labor the device shown in Figures 106 and 107 has proved very satisfactory. The oil barrel is placed on the north side of the building where it will be out of the sunlight and is mounted on a low wooden frame which permits the barrel to be rolled easily into place. (Fig. 106.)

A one-half inch pipe about one foot long, taper-threaded, is screwed into the spigot opening in the barrel. This pipe is connected by a piece of rubber hose of similar size which is attached to a one-half inch pipe leading under the sill into the incubator cellar. At a convenient height, three quarter-inch faucets are attached far enough apart on a horizontal arm so that three persons can fill lamps at the same time. (Figure 107.) Underneath the faucets is a drip pan to prevent waste. The pan is placed on a slight incline and fitted with a drain cock for removal of oil which accumulates.

A CATCHING-HOOK.

Improved by R. C. LAWRY.

Every poultry farm should have several catching-hooks. They save time in catching fowls and prevent much of the fright and injury which usually occurs on such occasions.

The catching-hook here described is an improvement of an old invention. (Figs. 108, 109 and 110.) The changes made are, first that the wire is so fortified and braced that it remains practically rigid (Fig. 109) and second, that the hook end is so bent that it permits the shank of the fowl to be easily caught and held effectively, but without injury to the shank owing to the restricted entrance which prevents the shank from being easily withdrawn, and the large aperture which gives freedom of action while the shank is held. (Fig. 110.) The shank, however, is easily released by the attendant.

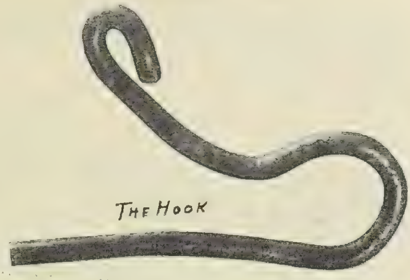

FIG. 110.—*The catching-hook. Note end of wire turned back to prevent injury, wide opened to catch quickly and restricted clutch and enlarged hold.*

The hook is made from a broom handle and a six-foot piece of number 10 steel wire which can easily be bent into the proper shape. (Fig. 110.)

The catching-hook in actual use is shown in Fig. 108. The wire is less conspicuous than the wooden end which attracts the fowls' attention while the hook catches the shank. The fowl is then gently drawn from the flock and the foot released.

FIG. 111.—*The chick feed-trough in use.*

A CHICK FEED-HOPPER.

Planned by R. C. LAWRY.

The hopper-feeding of finely cracked grain to young chicks calls for a device with a large available feeding surface, handy to fill, easy to clean and which will prevent the chickens from scratching out the

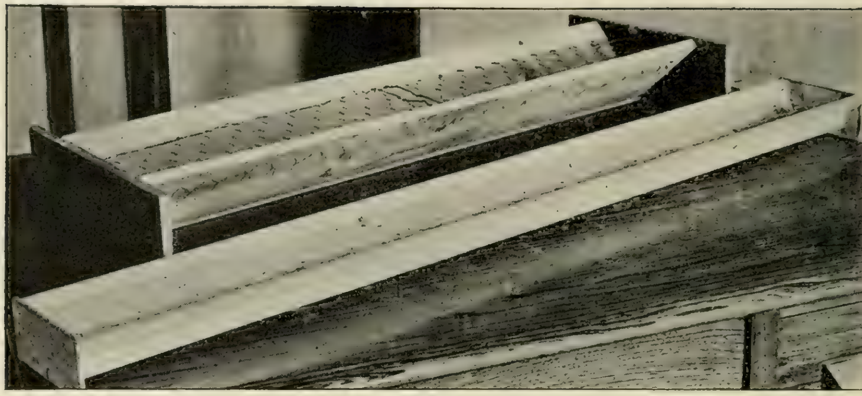

FIG. 112.—*Two feed-troughs for chickens, one made of galvanized iron eaves-trough, the other a simple V-shaped wooden trough. Each is covered with a ¾-inch mesh chicken-wire.*

grain. Such a device is shown in Figs. 111 and 112. It is made by cutting a galvanized iron feed-trough in suitable lengths and soldering a strip of three-quarter-inch mesh galvanized chicken-wire over the top. The surface of the wire should be about an inch below the edges of the trough to prevent the throwing out of grain.

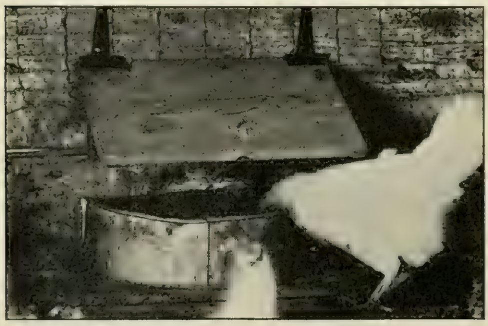

FIG. 113.—*Cover for water-pan, lowered. The hens cannot enter the pan. The over-hanging incline top and the end pieces keep out litter and dust.*

The ordinary wooden V-shaped trough can be similarly adapted; care being taken to cut the wire so that there will be no long points of wire to injure the chickens.

A WATER-PAN COVER.

Planned by JAMES E. RICE.

An inexpensive, handy, serviceable device for keeping the water-pan clean is shown in Figs. 113 and 114. It is easy to empty or fill. The pan should be placed on a slatted platform ten inches above the floor. It may be used to water one or two pens from the same pan.

A REMOVABLE FLOOR FOR CHICKEN SHELTER.

Adapted by R. C. LAWRY.

A removable floor is a great convenience and also a labor saver. It permits easy cleaning and thorough disinfection. Chicken coops and houses should be kept clean and free from mites. This is likely to be neglected with the rush of work in the rearing season. The type of house here shown (Fig. 115) is not the best. A summer house should provide for more fresh air, and for the sake of economy in construction, should be square rather than long and narrow. Land plaster or soil scattered over the floor will keep the air more wholesome and the floor will be more easily cleaned.

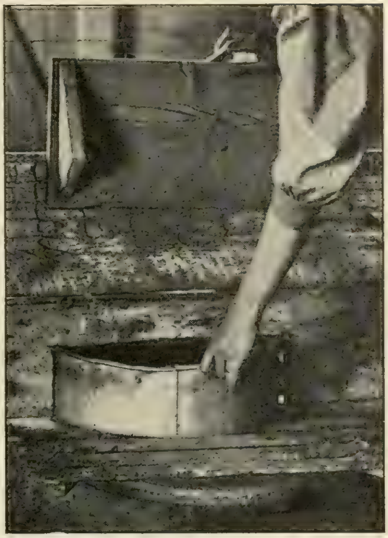

FIG. 114.—*The cover raised for emptying or filling the pan. The water-pan supplies two pens which saves about one-half the labor of watering. A swinging fender suspended from the partition over the pan prevents the fowls from running through the opening when the pan is removed. This is unnecessary with most breeds.*

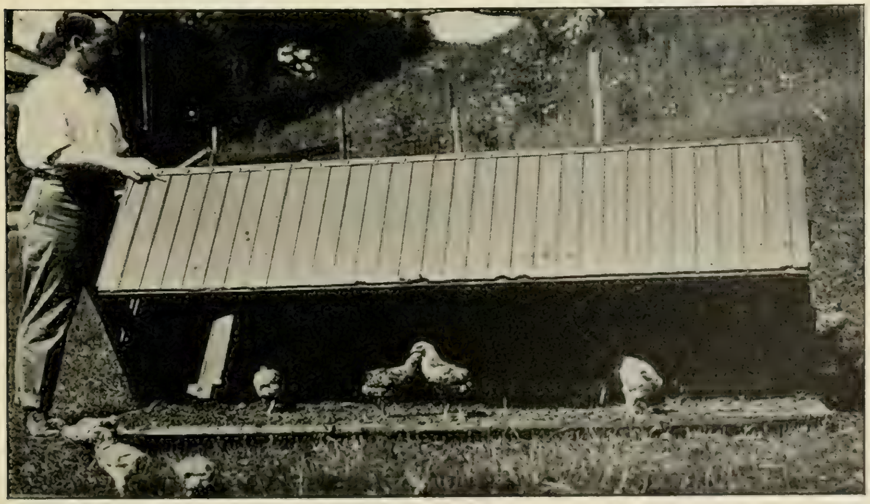

FIG. 115.—*The summer shelter tipped over, for cleaning. Note the ease with which the cleaning and disinfecting can be performed.*

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Poultry Husbandry

COMPARISON OF FOUR METHODS OF FEEDING EARLY HATCHED PULLETS

BY JAMES E. RICE

ITHACA, N. Y.

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FOUR METHODS OF FEEDING EARLY HATCHED PULLETS.

The object of the experiment here described was to find out how to feed early hatched pullets in order to secure best results in development, production and profit. While early pullets are generally recognized as the most profitable winter layers, it is commonly supposed that pullets hatched extra-early are not so well adapted to this purpose.

It has been thought that these earliest pullets should receive special treatment designed to check the laying tendency during late summer, with the hope of getting larger egg yield in early winter. This treatment is called *retarding*. The pullets, just approaching maturity, are allowed a grass run, and a satisfying ration of whole grain with a limited proportion of beef scrap, but no ground grain.

It is thought by many that if these pullets should be *Forced*—i. e., fed a rich, stimulating mash to induce egg production— they will lay a few small eggs, and molt prematurely, thus greatly reducing their vitality; that, in this case, it would be a long time before they would resume egg production, their bodies would be permanently stunted, and their eggs would continue smaller than is natural to their variety.

This experiment was undertaken with the hope of obtaining results, either for or against these theories, and of finding a method of feeding which could be recommended for early hatched pullets.*

PART I.—A COMPARISON OF FEEDING GROUND GRAIN AND UNGROUND GRAIN.

The experiment was begun with eighty Single Comb White Leghorn pullets, and conducted for a term of 364 days, the time being divided into thirteen periods of twenty-eight days each. It was started July 28, 1906, and closed July 27, 1907.

The four pens were numbered 1, 2, 3 and 4, respectively, and each contained twenty pullets hatched February 27th, making them five months old.

Some of the pullets were laying (though most were less mature) and all seemed to be healthy. They were so selected that the flocks as

Clara Nixon, Assistant in Poultry Husbandry, conducted the experiment here discussed and prepared a large part of the matter for publication.

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* The words *Forced* and *Retarded* are used in this bulletin in connection with the theory above mentioned in order to make the results more easily understood. It must not be assumed that because the terms *Forced* and *Retarded* are used in discussing the various pens that the theory is accepted as true. It was one of the chief objects of the experiment to find out whether or not these theories were correct.

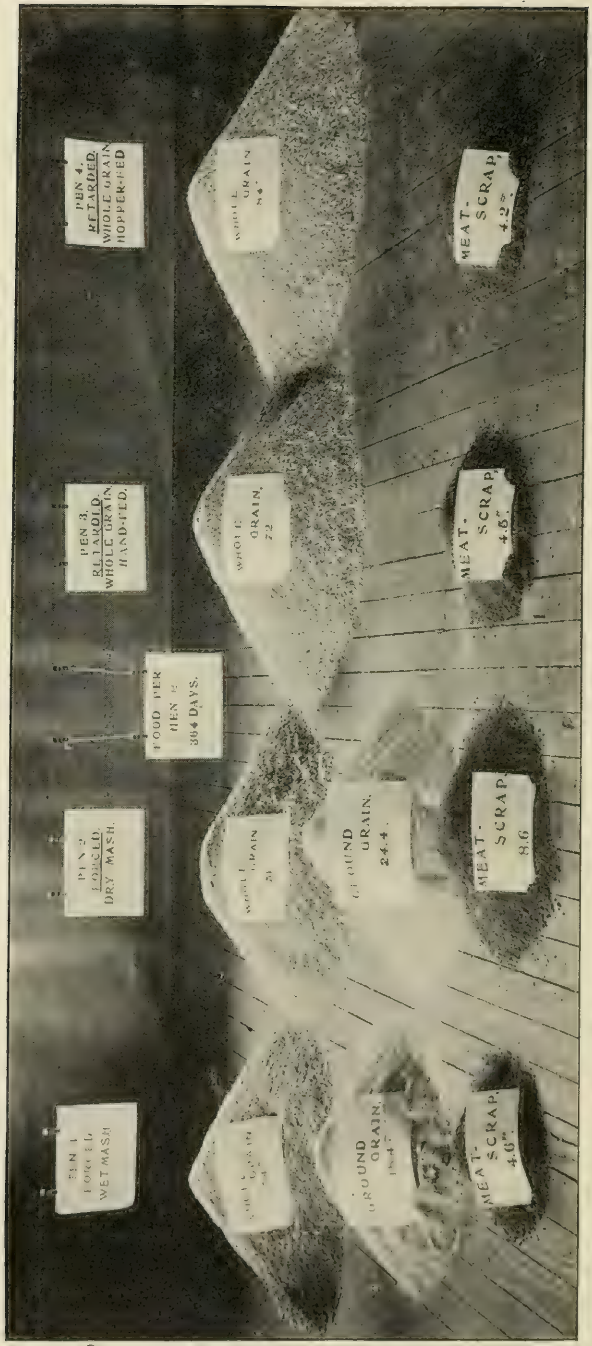


PLATE I.—*The amount of each kind of food consumed by each pen of fowls. Observe that the chief difference is in the ground grain.*

nearly as possible, were equal in weight, vigor and maturity, and their surroundings were practically alike. No males were put in the pens till December 1st, 1906.

The pens were all in one house, and were separated from each other by wire partitions. Each had a floor space of 86 square feet, or 4.3 square feet per hen. The house had 13.2 square feet glass surface, and 10 square feet of cloth surface. The entire air space was about 2,350 cubic feet, or 29.3 cubic feet per hen. Except on extremely cold days, the cloth windows were removed in the morning, the openings being covered only by wire netting.

There being only two yards available for the four pens, the hens were alternately allowed a grass run until November 20, 1906. From that time until March 20, 1907, they were confined in the pens; but from the latter date they were alternated as before until the close of the experiment.

The pullets were weighed at the beginning of each period of twenty-eight days, and also at the end of the experiment. From August 1, 1906, to March 1, 1907, and from July 1 to July 27, 1907, they were inspected individually each week as to their condition of molt. Between March 1st and July 1st they were examined only once each period of twenty-eight days, at the time of weighing. To make sure that the molt was correctly observed, the pullets were dipped in Diamond dyes at the beginning of the molting observations, thus making any new white feathers distinctly visible.

The hens were trap-nested during the entire time, and individual records kept. The eggs were weighed for six consecutive periods, and after that for a week at a time at intervals of two months, until the close of the experiment. Eggs from each pen were incubated, and records kept of the results.

Methods of feeding.

Pen I—*Forced*—received the grain mixture morning and night in the litter and wet mash at noon.

Pen II—*Forced*—received the grain mixture morning and night in the litter and dry mash in a hopper open at all times.

Pen III—*Retarded*—received grain morning, noon and night in litter, and beef scrap once a day in a trough.

Pen IV—*Retarded*—received grain mixture and beef scrap in a hopper open at all times.

The pullets in all four pens had grit, oyster shell, and water always before them, and were given mangel beets and green cut bone at intervals during the period of close confinement.

The nutritive ratio of the food consumed was as follows:

		N. R.
Pen 1	Wet Mash and Grain	1 : 4.6
" 2	Dry Mash and Grain	1 : 4.4
" 3	Hand-fed Grain	1 : 5.5
" 4	Hopper-fed Grain	1 : 5.8

Kinds and prices of feed.

Feed.—Four grain mixtures were used during the experiment, though the fowls were all fed the same mixture at any one time. All mixtures were compounded by weight:

Mixture I. Fed July 28 to September 8, 1906.

1 Cracked corn.
1 Wheat.
1 Oats.

Mixture II. Fed September 9 to December 8, 1906.

3 Cracked corn.
4 Wheat.
1 Oats.

Mixture III. Fed December 9, 1906, January 18, 1907.

4 Cracked corn.
3 Wheat.
1 Oats.

Mixture IV. Fed January 19 to February 16, 1907.

3 Cracked corn.
3 Wheat.
1 Oats.
1 Buckwheat.

From February 17 to April 12, Mixture III was used, and Mixture II was fed from April 13 to the end of the experiment.

Only one mash mixture for the *forced* pens was used:

2 Corn meal.
2 Wheat middlings.
2 Beef scrap.
1 Wheat bran.
1 Alfalfa meal.

Prices per Cwt. for food fed.

Corn	$1.20
Wheat	1.75
Oats	1.30
Buckwheat	1.20
Peas	1.00
Corn meal	1.25
Wheat middlings	1.30
Beef scrap	2.25
Wheat bran	1.20
Alfalfa meal	1.60
Green cut bone	1.00
Beets	.25
Grit	.50
Shell	.60

TABLE XIII. FOOD CONSUMED PER HEN IN 364 DAYS.
(DEDUCTION FROM TABLES 1–12.)†

		Total food.	Food per hen.	Cost food per hen.	Per cent. grain.	Per cent. mash.	Per cent. meat.	Grit per hen.	Shell per hen.
Pen 1	Wet Mash	1244.6	77.2	1.11	69.3	24.0	6.1*	1.77	2.04
Pen 2	Dry Mash	1666.9	84.1	1.23	56.7	39.0	9.8*	1.32	2.13
	Pens 1 and 2 Forced	**2911.5**	**80.6**	**1.17**	**63.0**	**31.5**	**7.9***	**1.54**	**2.08**
Pen 3	Hand FedGr.	1348.4	76.1	1.10	94.0		5.6	3.00	2.96
Pen 4	Hopper Fed Gr	1578.9	88.5	1.31	94.4		4.9	1.27	2.25
	Pens 3 and 4 Retarded	**2927.3**	**82.3**	**1.20**	**94.2**		**5.2**	**2.13**	**2.60**

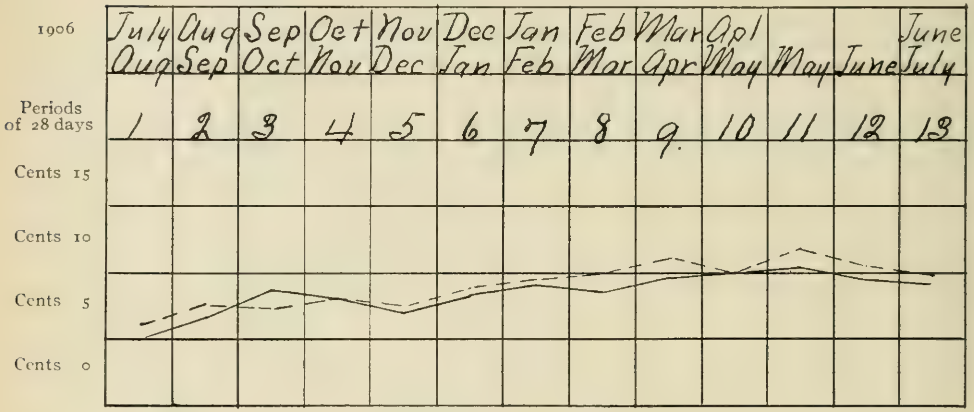
* Meat is included in Mash.

The average quantity of food consumed per hen by the *retarded* hens was about two pounds more than that eaten by the *forced* hens, at a cost of three cents more per hen. (Table 13.) The relative cost of food per hen for each period is shown in Fig. 117.

The hens having whole grain ate 38 per cent. more grit than those having part ground grain; and, though laying less eggs, they consumed

† Tables 1–12 are published separately in a supplement for limited distribution to those who may desire the original data from which the tables in this bulletin are drawn. They will be sent only on special application.

27.9 per cent. more shell. The proportion of mash to total food eaten by the *forced* hens was 31.5 per cent., and the average amount of meat eaten in the mash was 7.9 per cent. of total food. The *retarded* hens had no mash, but 5.2 per cent. of their total food was beef scrap. The



Forced——————————Pens 1 and 2.
Retarded.......................Pens 3 and 4.

FIG. 117.—*Forcing vs. retarding pullets. The cost of food per hen.*

Note the greater amount of food consumed per hen and per pound live weight when the hens were in heaviest laying, in March, April and May.

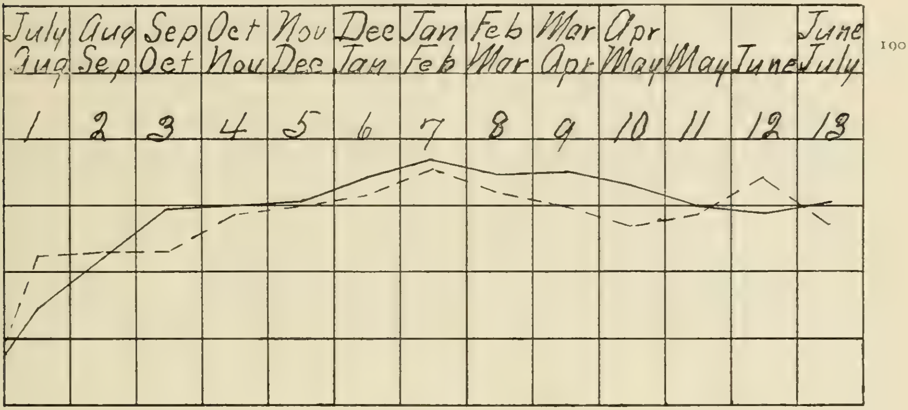
retarded hens were given nearly all the beef scrap they would eat, and the proportion varied at different times. The proportion of meat eaten by the *forced* hens varied according to the quantity of mash consumed.

TABLE XIV.—AVERAGE GAIN IN WEIGHT PER HEN IN 364 DAYS.

(DEDUCTION FROM TABLES 1–12.)

		First weight.	Last weight	Gain per hen.	Per cent. gain.
Pen 1	Wet Mash and Grain	2.4	3.56	1.16	48%
Pen 2	Dry Mash and Grain	2.26	3.49	1.23	54
	Forced Pens 1 and 2	**2.33**	**3.52**	**1.19**	**51**
Pen 3	Hand Fed Grain	2.49	3.12	.63	25
Pen 4	Hopper Fed Grain	2.38	3.58	1.20	50
	Retarded Pens 3 and 4	**2.43**	**3.35**	**.91**	**37**

The *retarded* hens were slightly larger at first (Table 14), and gained rapidly in weight during the first period. The second period the *forced* hens nearly equalled them in weight. The third period the *forced* hens were heavier, and remained so nearly to the end of the experiment. However, during the twelfth period, the *retarded* hens averaged slightly heavier than the *forced* hens. Fig. 118.



Forced——————————————Pens 1 and 2.
Retarded. . . . . .Pens 3 and 4.

FIG. 118.—*Forcing vs. retarding pullets. Average weight of hens.*

It will be noticed that the highest increase in weight was during January when the pullets were about to commence their heaviest laying, and the average weight per hen decreased continuously until the close of the active laying period, July.

The gain in weight among the *forced* hens was about 1.2 pounds per hen, or fifty per cent. on the first weight. The gain of the *retarded* hens was nearly one pound, or 37 per cent. on the first weight.

TABLE XV.—AVERAGE EGG PRODUCTION PER HEN IN 364 DAYS.

		Total eggs.	Eggs per day.	Per cent. eggs produced.	Average eggs per hen.	Value eggs per hen.	Cost per dozen eggs.
Pen 1	Wet Mash and Grain	1955	5.37	33.3	121.4	2.36	.109
Pen 2	Dry Mash and Grain	2561	7.03	35.5	129.3	2.57	.114
	Forced Pens 1 and 2	**4516**	**6.2**	**34.4**	**125.3**	**2.46**	**.111**
Pen 3	Hand Fed Grain..	1967	5.40	30.5	110.7	1.57	.119
Pen 4	Hopper Fed Grain	1904	5.17	29.0	107.5	2.05	.147
	Pens 3 and 4 Retarded	**3871**	**5.28**	**29.7**	**109.1**	**1.81**	**.133**

The relatively low egg production may have been due to the following well recognized contributory causes:

a The shock of dipping in diamond dyes for the molting observation.
b Repeated handling in weighing, and inspecting for molt each week.
c Excitement caused by many visitors.
d Lack of freedom due to alternation on limited grass runs.
e Early hatching and premature laying (a possibility).

The production at first was very small as would be expected of such young pullets. In both cases the egg yield increased rapidly the first and second periods, the *retarded* hens having slightly the lead. After that time, with but few exceptions, the *forced* hens were ahead, until the close of the experiment. Fig. 119.

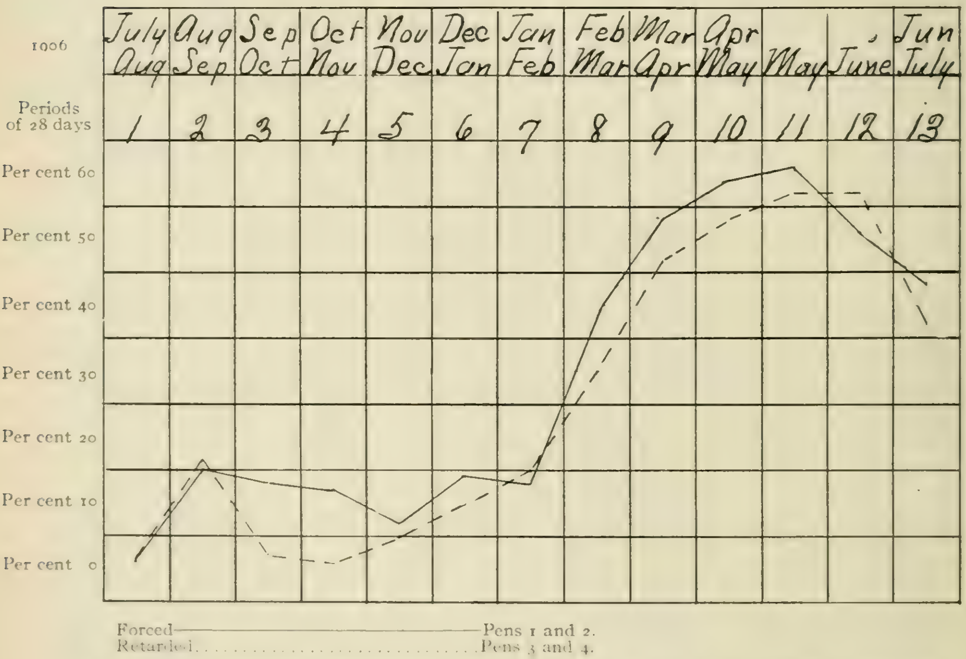


FIG. 119.—*Forcing and retarding pullets. A comparison of per cent egg production.*

Note that, although the per cent production of both the *forced* and the *retarded* flocks differed widely during the various periods, it increased or decreased uniformly, the production of the *forced* flocks remaining most of the time 3 to 5 per cent higher than that of the *retarded* flocks.

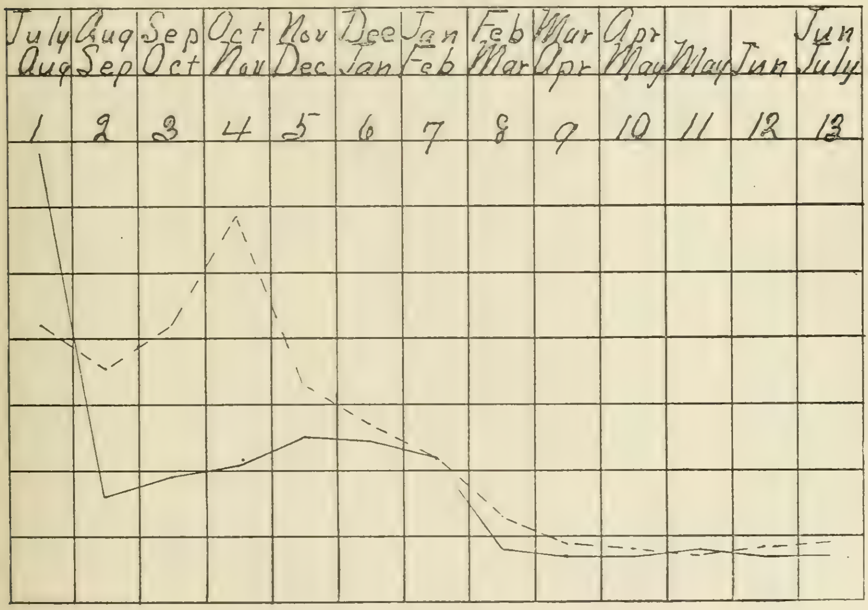
The *forced* hens gave about one and one-half dozen more eggs per hen than the *retarded*, and the value of eggs per hen per year was sixty-five cents more in the *forced* than in the *retarded* pens (Table 15).

Cost per dozen eggs.

From the beginning of the experiment until February, 1907, the cost per dozen eggs was decidedly less in the *forced* pens. (Tables 1–12.) After that time the cost was much less in both cases, and the difference between *forced* and *retarded* was small. Fig. 120. For the whole year, the average cost per dozen eggs was twenty per cent. less in the *forced* than in the *retarded* pens.

Relationship between egg production and gain in weight.

It is generally believed that hens which lay earlier and produce more eggs, will be smaller. Tables 1 to 12 and Figs. 118 and 119 show



Forced——————————————Pens 1 and 2.
Retarded..............................Pens 3 and 4.

FIG 120.—*Forcing and retarding pullets. Cost per dozen eggs.*

The cost per dozen eggs with the *retarded* flocks, was decidedly higher during the months of September, October, November and December, due to the relatively smaller number of eggs which they produced. The food cost per dozen eggs, with all flocks, was high because of the amount of food required to produce growth.

that for the first two periods, the *retarded* hens were ahead in both production and gain in weight. After that time, the *forced* hens made the better record in both directions. Individual records of early and late productions (Table 16) show that the sixteen earliest layers averaged 3.6 pounds while the sixteen latest layers averaged 3.2 pounds. Table 16

shows only relative results, comparing the extremes of production. It does not follow that the earliest layers were the largest hens in the flocks, nor that they were the most prolific hens.

A comparison of the sixteen most prolific and sixteen least prolific hens, shows that the least prolific hens averaged one-tenth of a pound heavier. (Table 17.)

The largest sixteen hens laid 17 less eggs per hen than the sixteen smallest hens from all pens. (Table 21.) It will be noted that the hens compared in tables 16 and 17 are not the same. In only four cases were the most prolific hens among the earliest producers.

TABLE XVI.—INFLUENCE OF EARLY PRODUCTION ON MOLTING, WEIGHT OF HEN AND PROLIFICACY.

(DEDUCTIONS FROM TABLES 1–12 AND ORIGINAL RECORDS.)

	Sixteen Hens First Commencing to Lay. Four Hens from Each Pen.					Sixteen Hens Last Commencing to Lay. Four Hens from Each Pen.				
	No. hen.	Began laying.	Wt. of hen at close of ex.	No. eggs.	Days molting.	No. hen.	Began laying.	Wt. of hen at close of ex.	No. eggs.	Days molting.
Pen 1. Wet Mash and Grain.	133	Aug. 16	4.0	83	42	26	Apr. 14	3.0	34	98
	311	Aug. 26	3.1	71	60	97	Feb. 2	3.4	17	97
	336	Aug. 26	4.3	40	70	61	Nov. 28	3.4	59	112
	147	Sep. 6	4.3	93	140	328	Dec. 14	3.5	52	119
Average		Aug. 27	3.9	71.7	78		Jan 30	3.3	40.5	106.5
Pen 2. Dry Mash and Grain.	346	Aug. 1	3.8	129	84	70	Feb. 18	5.1	4	112
	305	Aug. 4	4.1	90	77	60	Dec. 24	3.6	112	140
	348	Aug. 11	3.5	130	91	82	Dec. 19	3.4	63	63
	138	Aug. 23	3.7	40	98	78	Nov. 9	3.0	94	84
Average		Aug. 17	3.7	97.2	87.5		Jan. 28	3.7	68.2	99.7
Forced		**Aug. 21**	**3.8**	**84.4**	**82.7**		**Jan. 29**	**3.5**	**54.3**	**103.1**
Pen 3. Hand Fed Grain.	324	July 28	3.3	62	112	99	May 1	2.1	30	98
	314	Aug. 17	3.2	53	126	150	Feb. 7	2.5	79	91
	347	Aug. 17	2.8	99	63	159	Jan. 5	3.2	60	43
	317	Aug. 21	3.6	89	56	141	Dec. 10	2.9	71	109
Average		Aug. 2	3.2	75.7	89.2		Mar. 7	2.6	60	85.2

TABLE XVI.—INFLUENCE OF EARLY PRODUCTION ON MOLTING, WEIGHT OF HEN AND PROLIFICACY—*Continued.*

	Sixteen Hens First Commencing to Lay. Four Hens from Each Pen.					Sixteen Hens Last Commencing to Lay. Four Hens from Each Pen.				
	No. Hen.	Began Laying.	Wt. of hen at Close of ex.	No. Eggs.	Days Molting.	No. Hen.	Began Laying.	Wt. of hen at Close of ex.	No. Eggs.	Days Molting.
Pen 4. Hopper Fed Grain.	144	July 28	3.9	108	84	64	Dec. 12	3.5	75	112
	334	Aug. 4	3.4	113	119	154	Jan. 21	3.3	115	119
	341	Aug. 11	4.2	90	112	338	Jan. 7	3.7	78	42
	322	Aug. 16	3.1	92	105	83	Nov. 26	3.7	79	105
Average		Aug. 14	3.6	100.7	105		Dec. 17	3.5	86.7	94.5
Retarded		**Aug. 8**	**3.4**	**88.2**	**97.1**		**Jan. 23**	**3.0**	**73.3**	**89.8**
Grand Average 16 hens		**Aug. 15**	**3.6**	**86.3**	**89.9**	**16 hens**	**Jan. 26**	**3.2**	**63.8**	**96.4**

TABLE XVII.—INFLUENCE OF PROLIFICACY ON WEIGHT OF HEN, WEIGHT OF EGG AND MOLTING.

(DEDUCTIONS FROM TABLES 1–12.)

	Sixteen Hens Laying Most Eggs. Four Hens from Each Pen.					Sixteen Hens Laying Least Eggs. Four Hens from Each Pen.				
	Hen No.	No. of Eggs.	Wt. of hen.	Wt. eggs, Gms.	Days molting.	Hen No.	No. of eggs.	Wt. of hen.	Wt. eggs, Gms.	Days molting.
Pen 1. Wet Mash and Grain.	75	130	3.7	53.0	77	26	34	3.0	51.5	98
	353	122	3.7	59.7	28	336	40	4.3	56.8	70
	71	107	3.2	50.7	56	328	52	3.5	62.3	119
	147	93	4.3	44.4	140	90	54	2.5	45.2	70
Average		113	3.7	51.9	75.2		45	3.3	53.9	89.3
Pen 2. Dry Mash and Grain.	155	172	3.1	57.0	42	70	4	5.1	62.7	112
	55	145	3.5	61.7	84	319	6	4.0	65.0	63
	337	139	4.0	58.0	91	305	90	4.1	57.0	77
	87	141	3.3	51.9	77	78	94	3.0	54.6	84
Average		149.2	3.4	57.1	73.5		48.5	4.0	59.8	84

TABLE XVII.—INFLUENCE OF PROLIFICACY ON WEIGHT OF HEN, WEIGHT OF EGG AND MOLTING—*Continued.*

	Sixteen Hens Laying Most Eggs. Four Hens from Each Pen.					Sixteen Hens Laying Least Eggs. Four Hens from Each Pen.				
	Hen No.	No. of Eggs.	Wt. of Hen.	Wt. Egg. Gms.	Days Molting.	Hen No.	No. of Eggs.	Wt. of Hen.	Wt. Egg. Gms.	Days Molting.
Forced		**131.1**	**3.5**	**54.5**	**74.3**		**46.7**	**3.6**	**56.8**	**86.6**
Pen 3. Hand Fed Grain.	143	110	2.9	59.3	84	308	40	3.9	56.6	105
	347	99	2.8	52.1	63	314	53	3.2	54.0	126
	352	97	2.7	55.0	98	159	60	3.2	59.7	43
	317	89	3.6	56.0	56	150	79	2.5	46.0	91
Average		98.7	3.0	55.6	75.2		58	3.2	54.0	91.2
Pen 4. Hopper Fed Grain.	152	119	3.1	49.5	105	51	27	2.7	56.0	84
	154	115	3.3	49.1	119	357	65	3.7	59.9	82
	334	113	3.4	51.5	119	185	61	3.7	56.2	77
	144	108	3.9	58.0	84	64	75	3.5	57.6	112
Average		113.7	3.4	52.0	106.7		57	3.4	57.4	88.7
Retarded		**106.2**	**3.2**	**53.8**	**90.9**		**57.5**	**3.3**	**55.7**	**89.9**
Grand Av. both forced and retarded 16 hens		118.6	3.3	54.1	82.6	16 hens	52.1	3.4	56.2	88.2

FIG. 121.—*Pullet molting after first laying period. Pullet No.* 144, *from pen* 4 *(hopper-fed grain), in heavy molt. Note, in wings and on back, the colored feathers which have not been shed. The ragged appearance of the neck is due to pin-feathers. This pullet commenced to lay July* 28, *laid* 29 *eggs, ceased laying Sept.* 25, *molted* 89 *days, began again to lay Feb.* 23, *and laid* 108 *eggs during the year.*

Relation between prolificacy and early egg production.

Of the sixteen best layers from the four pens laying an average of 118 eggs (Table 17 and Table 18), eight began to lay before September first. These early layers were mostly in the *retarded* pens. Of the six pullets laying above 120 eggs each, all in the *forced* pens, only two began laying before September 1st, and one of these gave her first egg August 29th. Some few of the sixteen least prolific hens, averaging 52 eggs each, began to lay early, but most of them began at least two months later.

TABLE XVIII.—(DEDUCTIONS FROM ORIGINAL RECORDS) DATE OF FIRST PRODUCTION AND DAYS LOST. (NOT LAYING).

	MOST PROLIFIC HENS.				LEAST PROLIFIC HENS.			
	Hen No.	Eggs Laid.	Date First Egg.	Days Lost.	Hen No.	Eggs Laid.	Date First Egg.	Days Lost.
Pen 1 Wet Mash and	75	130	Sep. 25	234	26	34	Apr. 14	330
Grain	353	122	Oct. 6	242	336	40	Aug. 26	324
Forced	71	107	Sep. 22	257	328	52	Dec. 14	312
	147	93	Sep. 6	268	90	54	Nov. 2	310
Average		113		250		45		319
Pen 2 Dry Mash and	155	172	Sep. 6	192	70	4	Feb. 18	360
Grain	55	145	Oct. 28	219	319	6	Feb. 19	358
Forced	337	139	Aug. 11	225	305	90	Aug. 4	274
	87	141	Aug. 29	217	78	94	Nov. 9	270
Average		149.2		213.2		48.5		315.5
Pens 1 and 2 Total average Forced		**131.1**		**231.6**		**46.7**		**317.2**
Pen 3 Hand-fed	143	110	Oct. 6	254	308	40	Apr. 3	324
Grain	347	99	Aug. 17	265	314	53	Aug. 17	311
	352	97	Aug. 24	267	159	60	Aug. 31	304
	317	89	Aug. 21	279	150	79	Feb. 7	285
Average		98.7		266		58		306

DATE OF FIRST PRODUCTION AND DAYS LOST—*Continued.*

	MOST PROLIFIC HENS.				LEAST PROLIFIC HENS.			
	Hen No.	Eggs Laid.	Date First Egg.	Days Lost.	Hen No.	Eggs Laid.	Date First Egg.	Days Lost.
Pen 4	152	119	Aug. 22	245	51	27	Oct. 21	337
Hopper-fed Grain	154	115	Jan. 21	248	357	65	Aug. 25	299
	334	113	Aug. 4	251	85	61	Dec. 18	303
	144	108	July 28	256	64	75	Dec. 12	289
Average		113.7		250		57		307
Pens 3 and 4 Total average Retarded		**106.2**		**258**		**57.5**		**306.5**
Grand Average of sixteen hens		**118.6**		**244.8**		**52.1**		**311.8**

TABLE XIX.—INFLUENCES OF EARLY OR LATER EGG PRODUCTION ON WINTER EGG SUPPLY.

	Sixteen Earliest Producers. Four in Each Pen.						Sixteen Hens First Beginning to Lay After Sep. 1st. Four in Each Pen.					
	Hen No.	Total No. Eggs.	Date First Egg Laid.	No. Laid Before Molting.	Molt.	Date of Renewed Prod.	Hen No.	Total No. Eggs.	Date First Egg Laid.	No. Laid Before Molting.	Molt.	Date of Renewed Prod.
Pen 1	133	83	Aug. 16	7	Few feathers	Dec. 2	75	130	Sep. 25	36	Few feathers	Feb. 8
Wet Mash and Grain	311	71	Aug. 26	38	Heavy	Feb. 25	25	83	Sep. 6	8	Heavy	Feb. 2
Forced	336	40	Aug. 26	1	"	Feb. 29	79	68	Sep. 6	20	Few feathers	Jan. 15
	147	93	Sep. 6	20	"	Feb. 22	147	93	Sep. 6	20	Few feathers	Feb. 22
Average		71.7		16.6				93.5		21		
Pen 2	346	129	Aug. 1	30	"	Jan. 13	155	172	Sep. 6	66	Few feathers	Dec. 2
Dry Mash and Grain	305	99	Aug. 4	34	"	Feb. 25	157	76	Sep. 2	34	Heavy	Jan. 11
(Forced)	348	130	Aug. 11	3	"	Feb. 10	321	105	Oct. 1	20	"	Jan. 12
	138	40	Aug. 3	3	"	Jan. 26	86	128	Oct. 19	128		
Average		99.5		17.5				120.2		62		
(Forced Pens 1 and 2)		**85.6**		**17.0**				**106.8**		**41.5**		
Pen 3	324	62	July 28	5	"	Dec. 14	143	110	Oct. 6	17	Heavy	Jan. 6
Hand-fed	314	53	Aug. 17	6	"	Jan. 9	316	81	Dec. 7	81		
Grain	347	99	Aug. 17	73	"	Mar. 24	141	71	Dec. 10	2	Few feathers	Dec. 2
(Retarded)	317	89	Aug. 21	38	"	Feb. 2	94	69	Dec. 30	69		
Average		75.7		30.5				82.7		42.2		

INFLUENCE OF EARLY OR LATER EGG PRODUCTION ON WINTER EGG SUPPLY—*Continued.*

	FOUR EARLIEST PRODUCERS. FOUR IN EACH PEN.						FOUR FIRST BEGINNING TO LAY AFTER SEP. 1ST.					
	Hen No.	Total No. Eggs.	Date First Egg Laid.	No. Laid Before Molting.	Molt.	Date of Renewed Prod.	Hen No.	Total No. Eggs.	Date First Egg Laid.	No. Laid Before Molting.	Molt.	Date of Renewed Prod.
Pen 4	144	108	July 28	29	Heavy	Feb. 23	151	40	Oct. 24	13	Heavy	Feb. 10
Hopper-fed	322	92	Aug. 16	17	"	Dec. 28	83	79	Nov. 26	16	New feathers	Feb. 20
Grain	341	90	Aug. 11	19	Few feathers	Dec. 8	140	65	Sep. 2	30	Heavy	Dec. 29
(Retarded)	334	113	Aug. 4	1	Heavy	Sep. 5	345	104	Oct. 10	23	Few feathers	Dec. 11
Average		100.7		16.5				84		20.5		
Retarded (Pens 3 and 4)		**88.2**		**23.5**				**72**		**31.3**		
Grand average		**86.9**		**20.2**				**95.0**		**36.4**		

Of the sixteen earliest layers, seven laid less than ten eggs before molting. One of these began laying again September 6, thirty-two days later, but most did not renew egg production before December to February, four or five months later. The hens which laid more eggs before molting began again about the same time as the others. During the time thus lost eggs were about forty cents per dozen, while after that time the price was much lower. Of the sixteen hens which first began production after September 1st, three did not molt at all until the end of the experiment. The average number of eggs laid before molting by these hens was 36.4, against 20.2 of the sixteen beginning earlier. Their average egg production during the year was 92. against 86.9 of the earliest layers. Table 19.

Effect of a forcing mash on the winter egg supply.

Deductions from Tables 1–12.

The number of eggs produced during October, November, December and January, the months after molting when the hens usually lay the fewest eggs and when the late hatched pullets are not mature enough to lay, was as follows:

	Pen 1—309 eggs	$25\frac{9}{12}$ dozen	19.2 eggs per hen.
	Pen 2—452 eggs	$37\frac{8}{12}$ dozen	22.6 eggs per hen.
Forced—Pens 1 and 2	**—761 eggs**	**$63\frac{5}{12}$ dozen**	**20.9 eggs per hen.**
	Pen 3—261 eggs	$21\frac{9}{12}$ dozen	14.5 eggs per hen.
	Pen 4—284 eggs	$23\frac{8}{12}$ dozen	15.7 eggs per hen.
Retarded—Pens 3 and 4	**—545 eggs**	**$45\frac{5}{12}$ dozen**	**15.1 eggs per hen.**

This gives the *forced* flocks eighteen dozen more eggs than were produced by the *retarded* hens. The average market price of these eggs was thirty-four cents per dozen, making an excess in value of $6.12 in favor of the *forced* hens, during the months of scarcity. The total eggs from all four pens during these months was $108\frac{10}{12}$ dozens, worth at the market price $37.00.

TABLE XX. SIZE AND WEIGHT OF EGGS. (DEDUCTIONS FROM TABLES 1–12.)
WEIGHT OF EGGS IN GRAMMES.

		Av. wt. for year Grams.	First weight, Grams.	Last weight, Grams.	Per cent. Gain.
Pen 1	Wet Mash and Grain	54.0	51.5	57.9	12.4%
Pen 2	Dry Mash and Grain	53.7	47.6	54.8	15.1
	Forced	**53.8**	**49.5**	**56.3**	**13.7**
Pen 3	Hand-fed Grain	53.3	47.6	52.6	10.5
Pen 4	Hopper-fed Grain	52.3	46.7	52.3	11.9
	Retarded	**52.8**	**47.1**	**52.4**	**11.2**

A comparison of eggs from the *forced* and *retarded* pens, shows little difference in their weight except during the fourth period (October–November), when the *forced* hens gave slightly larger eggs. This was, however, due to one pen, the others being about equal. At the close of the experiment the eggs from the *forced* pens were slightly larger.

Influence of size of hen on weight of egg and prolificacy.

Individual records make it plain that, as a rule, the larger hens laid larger eggs. (Table 21.) In some cases, however, a small hen laid a larger egg than a hen of greater size. The hens compared in this respect are in some cases the same as those compared in Tables 16 and 17, but the combinations for the purpose of comparison are entirely different.

TABLE XXI.—INFLUENCE OF SIZE OF HEN ON WEIGHT OF EGGS AND PROLIFICACY. (DEDUCTIONS FROM TABLES 1–12.)

	SIXTEEN LARGEST HENS. FOUR FROM EACH PEN.				SIXTEEN SMALLEST HENS. FOUR FROM EACH PEN.			
	Hen No.	Weight of hen.	No. of eggs laid.	Weight of eggs, Grams.	Hen No.	Weight of hen.	No. of eggs	Weight of eggs Grams.
PEN 1. Wet Mash and Grain.	336	4.3	40	56.8	90	2.5	54	45.2
	147	4.3	93	64.4	26	3.0	34	51.5
	133	4.0	83	59.9	311	3.1	71	49.0
	77	4.0	17	57.6	71	3.2	107	50.7
Average		4.1	58.2	59.6		2.9	66.5	49.1
PEN. 2. Dry Mash and Grain.	305	4.1	90	57.0	157	2.2	76	56.9
	337	4.0	139	58.0	78	3.0	94	54.6
	319	4.0	6	65.0	155	3.1	172	57.0
	348	3.5	130	51.7	136	3.2	110	54.8
Average		3.9	91.2	57.9		2.8	113	55.8
Forced		**4.0**	**74.7**	**58.7**		**2.8**	**89.7**	**52.4**
PEN 3. Hand-fed Grain.	308	3.9	40	56.6	150	2.5	79	46.0
	145	3.7	69	62.0	352	2.7	97	55.0
	317	3.6	89	53.5	347	2.8	99	52.1
	306	3.5	87	56.0	141	2.9	71	59.5
Average		3.6	71.2	57.0		2.7	86.5	53.1
PEN 4. Hopper-fed Grain.	341	4.2	90	62.0	322	3.1	92	51.2
	144	3.9	108	58.0	152	3.1	119	49.5
	83	3.7	79	57.5	154	3.3	115	49.1
	85	3.7	61	56.2	334	3.4	113	51.5
Average		3.8	84.5	58.4		3.2	109.7	50.3
Retarded		**3.7**	**77.8**	**57.7**		**2.9**	**98.1**	**51.7**
Grand Av. of 16 hens both forced and retarded		**3.8**	**76.2**	**58.2**	**16 hens**	**2.8**	**93.9**	**52.0**

Influence of prolificacy on weight of eggs.

As a rule, the most prolific hens gave eggs of medium size, though some heavy layers produced very large eggs. The average weight of eggs from the sixteen best layers from all four pens was only three per cent. less than the average weight of those from the sixteen poorest layers. (Table 17.)

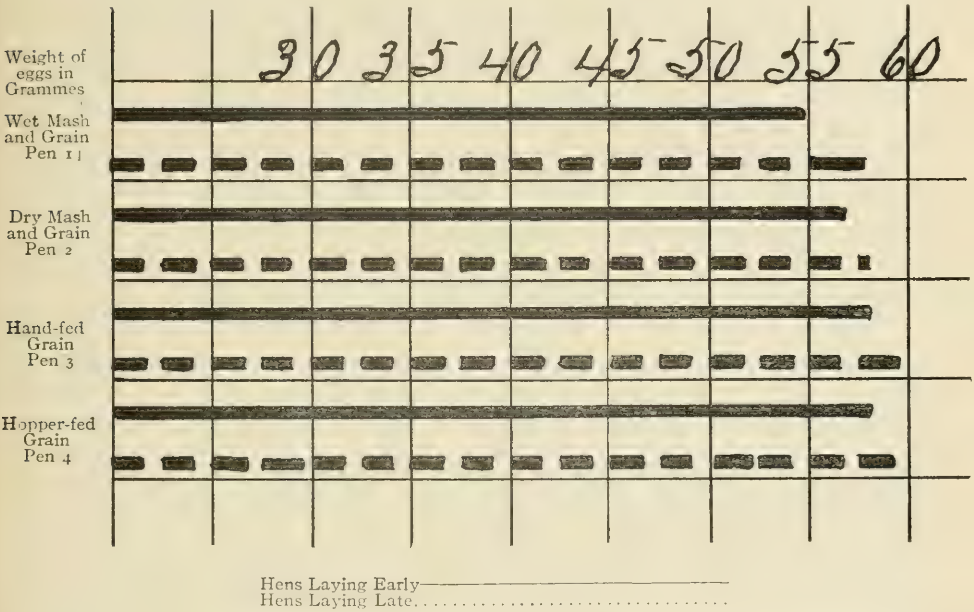


FIG. 122.—*Forcing and Retarding Pullets. Individual record showing weight of eggs in grammes. A comparison of early and late egg production.*

It will be noted that in all four hens the eggs from the hens whieh began later in the season to lay were from two to four grammes heavier than from the hens of the same age which began earlier to lay.

Influence of early egg production on weight of eggs.

Sixteen of the earliest layers and sixteen of the latest to commence laying were selected for the purpose of comparison. A graphic representation of the weight of eggs from these individuals shows slight though constant difference in favor of the latest layers. Fig. 122.

TABLE XXII.—FERTILITY AND HATCHABILITY OF EGGS.

DEDUCTIONS FROM TABLES 3, 6, 9, 12. AND FROM ORIGINAL RECORDS.

		No. of eggs incubated.	No. of chicks hatched.	Per cent. eggs hatched.	Per cent. fertile eggs.	Per cent. fertile eggs hatched.
Pen 1	Wet Mash and Grain	157	107	68.0	92.9%	73.2%
Pen 2	Dry Mash and Grain	214	164	77.6	91.0	84.7
	Forced	**371**	**271**	**72.8**	**91.9**	**78.9**
Pen 3	Hand-fed Grain	157	115	73.2	93.6	78.2
Pen 4	Hopper-fed Grain	226	128	56.6	94.6	58.8
	Retarded	**383**	**243**	**64.9**	**94.1**	**68.5**

Comparison of the fertility and hatchability of eggs.

Of the eggs which were incubated, 371 were from the forced pens and 383 were from the retarded pens. The eggs from each pen were placed in several machines, and the conditions affecting them were made as nearly alike as possible. While twelve more eggs from the *retarded* pens were put in the machines, the eggs from the *forced* pens gave 28 more chicks (11.5 per cent.) than those from the *retarded* pens. The fertility was slightly better in the *retarded* pens.

Influence of forced early egg production on fall and winter molt.

A comparison of molting in the *forced* and *retarded* pens shows few distinctive differences. (Fig. 123.) For five periods the *retarded* hens molted most; for five periods the *forced* hens molted most; and for three periods they were nearly alike. This, however, does not prove whether the early layers or the hens coming later into egg production molted for a longer time. Of thirty-two hens from the four pens, the sixteen beginning earliest to lay, molted on an average 89.9 days, while the sixteen beginning last to lay, averaged 96.4 days during the year. In nearly every case the hens beginning earliest to lay were molting during December and January when eggs were at a high figure. (Table 16.)

Influence of prolificacy on molt.

By an inspection of individuals it was found that pullets which laid a succession of eggs, no matter how many nor how few, did not usually molt while laying. When egg production stopped, they molted at least a few feathers, possibly a complete molt. A comparison of the layers,

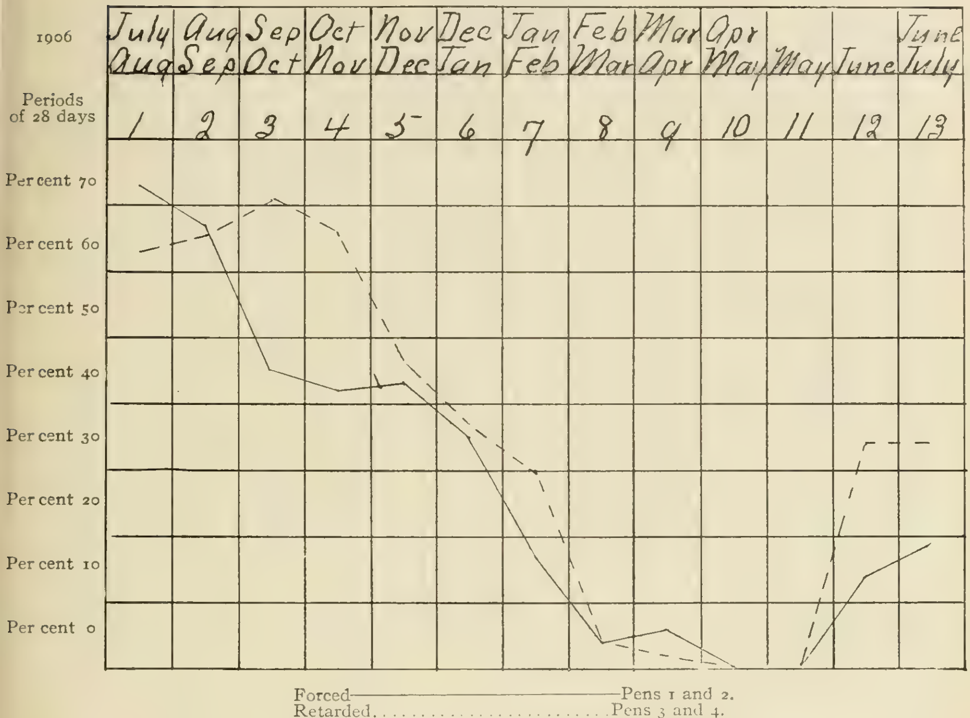


FIG. 123.—*Forcing vs. retarding pullets. A comparison of molting.*

It will be observed that the pullets which were retarded molted most. This is contrary to the generally accepted theory, and needs verification before being accepted as true.

and the pullets which had not laid, showed, however, fully as great a percentage of molting among the "loafers" as among the layers. The sixteen most prolific hens in the four pens molted, on an average, 82.4 days. The sixteen least prolific hens molted 88.2 days. So far as can be discovered from the data of this experiment, the molt is not greatly influenced by early egg production, nor by prolificacy.

Broodiness.

There was little broodiness during the experiment. The *forced* hens lost only three days from this cause, there being only one case of broodiness. The *retarded* hens lost twenty-three days due to eight hens; a loss about eight times as great as that sustained by the *forced* hens. This data would lead us to suspect that broodiness is in some way influenced by food supply but further proof will be necessary before conclusions can be drawn.

TABLE XXIII. MORTALITY IN 364 DAYS. (DEDUCTIONS FROM TABLES 1–12.)

		No. hens in Experiment.	Mortality.	Av. No. hens per year.	Per cent. Mortality.
Pen 1	Wet Mash and Grain*	20	6	16.1	30%
Pen 2	Dry Mash and Grain	20	1	19.8	5
	Forced Pens 1 and 2	**40**	**7**	**35.9**	**17.5**
Pen 3	Hand-fed Grain	20	2	18.3	10
Pen 4	Hopper-fed Grain	20	6	17.7	30
	Retarded Pens 3 and 4	**40**	**8**	**36.0**	**20**

* Two removals on account of sickness, counted as mortality.

The mortality among these hens was very great, though the greater part of it was in two of the four pens (Table 23). The percentage was slightly greater in the *retarded* pens, and the general "condition" of the fowls was not so good in the *retarded* as in the *forced* pens. The cause of this high mortality remains a mystery, unless the method of feeding was to blame. In any case, any disadvantages not included in the conditions of the experiment were shared alike by all four pens.

TABLE XXIV.—FINANCIAL STATEMENT.

DEDUCTIONS FROM TABLES 1-12 AND ORIGINAL RECORDS.

PEN 1.—WET MASH AND GRAIN.

Total Cost Food	$17.893	Total Value Eggs	$38.177
" " Loss Stock	2.108	" " Gain in weight	3.252
" " " Weight	.906	" Income	42.429
" Outgo	20.907		
Balance Profit	21.252		

PEN 2.—DRY MASH AND GRAIN.

Total Cost Food	$24.387	Total Value Eggs	$51.040
" " Loss Stock	.420	" " Gain in weight	3.648
" " " Weight	1.236	" Income	54.688
" Outgo	26.043		
Balance Profit	28.645		

Total. **FORCED PENS 1 and 2.**

Total Cost Food	$ 42.280	**Total Value Eggs**	$ 80.217
" " Loss Stock	2.528	**" " Gain in weight**	6.900
" " " Weight	2.142	**" Income**	97.117
" Outgo	46.950		
Balance Profit	50.167		

PEN 3.—HAND-FED GRAIN.

Total Cost Food	$19.620	Total Value Eggs	$39.040
" " Loss Stock	.786	" " Gain in weight	2.520
" " " Weight	1.188	" Income	41.560
" Outgo	21.594		
Balance Profit	19.966		

PEN 4.—HOPPER-FED GRAIN.

Total Cost Food	$23.265	Total Value Eggs	$38.310
" " Loss Stock	2.522	" " Gain in weight	3.948
" " " Weight	1.114	" Income	42.258
Total Outgo	26.901		
Balance Profit	15.357		

RETARDED PENS 3 and 4.

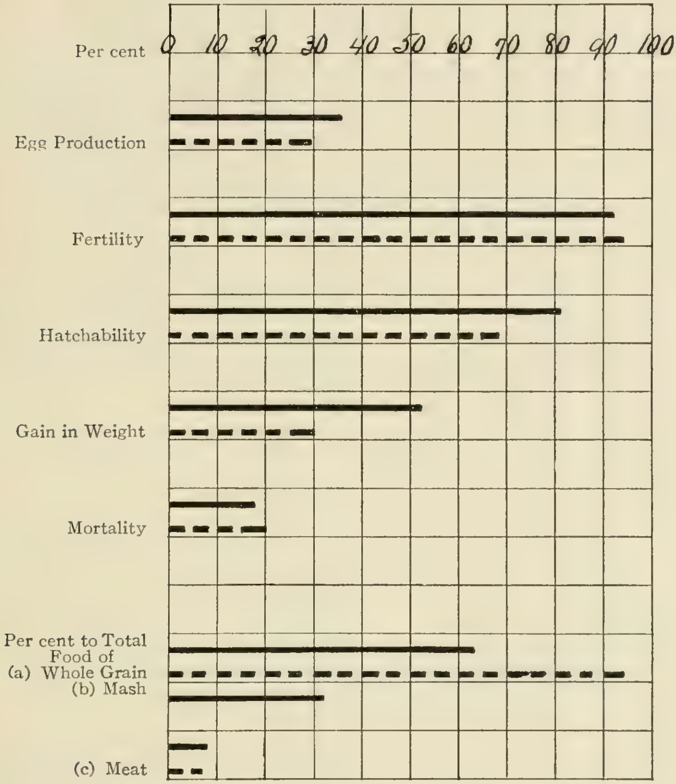
Total Cost Food	$ 42.885	**Total Value Eggs**	$ 77.350
" " Loss Stock	3.308	**" " Gain in Weight**	6.528
" " " Weight	2.302	**" Income**	83.818
" Outgo	48.495		
Balance Profit?	35.323		

SUMMARY.

TABLE XXV.—PROFIT PER HEN.

		Total income per hen.	Total outgo per hen.	Profit per hen.	Per cent. profit over cost of food.
Pen 1	Wet Mash and Grain	$2.63	$1.29	$1.34	106
Pen 2	Dry Mash and Grain	2.76	1.31	1.45	112
	Forced	**2.69**	**1.30**	**1.39**	**109**
Pen 3	Hand-fed Grain	2.34	1.22	1.12	93.8
Pen 4	Hopper-fed Grain	2.38	1.51	.87	56.2
	Retarded	**2.36**	**1.36**	**.97**	**75**

FIG. 124.—*Pullet molting after first laying period. Breast view of pullet No. 348 from pen 2 (dry mash and grain), in heavy molt, showing some of the flight feathers fully developed; some partly grown out; and some (the dark ones) still to be shed. The little inside coverts of the wings are still retained. This pullet commenced laying Aug. 1, laid 20 eggs before molting, ceased laying Sept. 7, molted 91 days, began again to lay Feb. 10, and laid 130 eggs during the year.*



Forced——————————————Pens 1 and 2.
Retarded..........................Pens 3 and 4.

FIG. 125.—*Forcing vs. Retarding Pullets. A chart of percentages.*

Notice that the forced pens led in percentage egg production, percentage hatchability and gain in weight.

Profit per hen.

The profit per hen in the *forced* pens was $1.39 against $0.97 in the *retarded* pens, a relative gain of *forced* above *retarded* of 38.3 per cent. (Table 25.) This was due partly to the greater egg production in the *forced* pens, particularly when eggs were high in price, and also to the less cost per dozen eggs. The value of gain in weight was an important factor, it being 14 per cent. greater in the *forced* than in the *retarded* pens. (See financial statement.) A graphic representation of percentages is given in Fig. 125.

PART II. A COMPARISON OF HAND FEEDING AND HOPPER FEEDING.

Since the data of the experiment indicate that, in Part I, *forcing* early hatched pullets gave better results than *retarding* them, a comparison of the methods used may be attempted. Two methods of forcing (wet mash and grain vs. dry mash and grain) and two methods of retarding (hand-fed grain and hopper-fed grain) were tried.

Food.

The dry mash hopper-fed hens and grain hopper-fed hens ate more per hen than the hand-fed wet mash and hand-fed grain hens, and at a slightly greater cost. (Table 13.) The hens receiving whole grain ate more grit and shell than those receiving part ground grain. The dry mash hens ate a less percentage of whole grain and a greater proportion of mash than the wet mash hens.

Gain in weight.

The dry mash hens made the largest per cent. of gain on their first weight, and also the largest gain in weight, though in size of fowls, they were third on the list. July 28, '06, they were the smallest hens in the experiment, though the difference was slight. (Table 14.)

Egg production.

The dry mash and grain fed hens, Pen 2, laid the most eggs per hen at the greatest value per hen, but the eggs cost slightly more per dozen than those of the wet mash and grain fed hens, Pen 1. (Table 15.) By periods, the egg production of the dry mash and grain fed hens was highest most of the time until the tenth period. Then the wet mash and grain fed hens gave the highest production, which continued to the end of the experiment. (Fig. 126.)

Weight of eggs.

Eggs from the dry mash and grain fed hens, Pen 2, reached full weight, two ounces, during the fourth period (October–November) while those from the other pens did not reach this weight before the sixth period (December–January) (Tables 1–12). The average weight of eggs for the whole year was slightly greater for the wet mash and grain fed hens, though the per cent. gain in weight of eggs was larger in case of the dry mash and grain fed hens. The smallest hens in the dry mash and grain fed pen laid larger eggs than the smallest hens in the wet mash and grain fed pen.

Eggs from the dry mash and grain fed hens were largest during the seventh period (January–February), but decreased in weight from that time to the close of the experiment. The reason for this decrease might be the heavier molt in this pen. The eggs from the wet mash and grain fed hens continued to increase in size.

Fertility and hatching power of eggs.

While the fertility in the dry mash and grain fed pen was least, the hatching power was best of all the four pens. Of the eggs from this pen which were put into machines, 77.6 per cent. gave good chickens. The hand-fed grain hens came next with 73.2 per cent. The hopper-fed grain hens gave best fertility, but fewest chickens for the eggs incubated. (Table 22.)

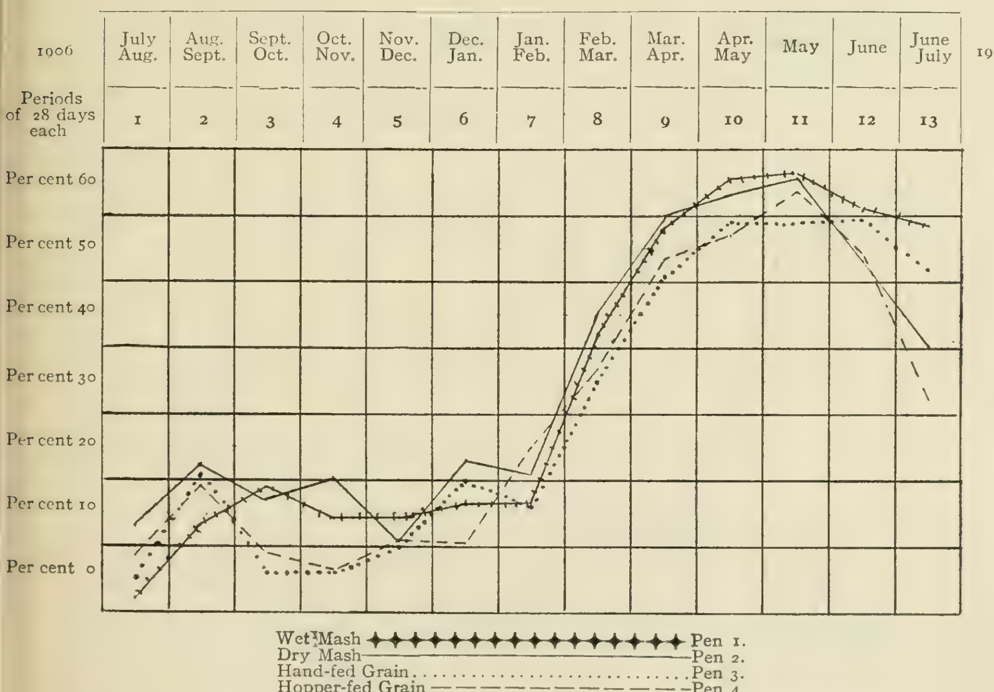


FIG. 126.—*Methods of forcing and retarding. Per cent. egg production.*

These curves of production furnish a striking illustration of the uniformity of production of different flocks during the same months, even under different conditions of feeding. It clearly points to the general conclusion that the seasons have a greater influence on production than does age of fowl or ordinary difference in methods of feeding.

Molting.

The molting during the first two periods of the experiment was mostly of chick-feathers, but the dry mash and grain fed hens and the hand-fed grain hens molted more. They also shed more at the beginning of the molting season of 1907. During the early part of the experiment the wet mash and grain fed hens molted least as they did also at the close.

The two hopper-fed flocks showed no molt for three months—April, May and June. The two hand-fed flocks shed no feathers during April and May. Fig. 127.

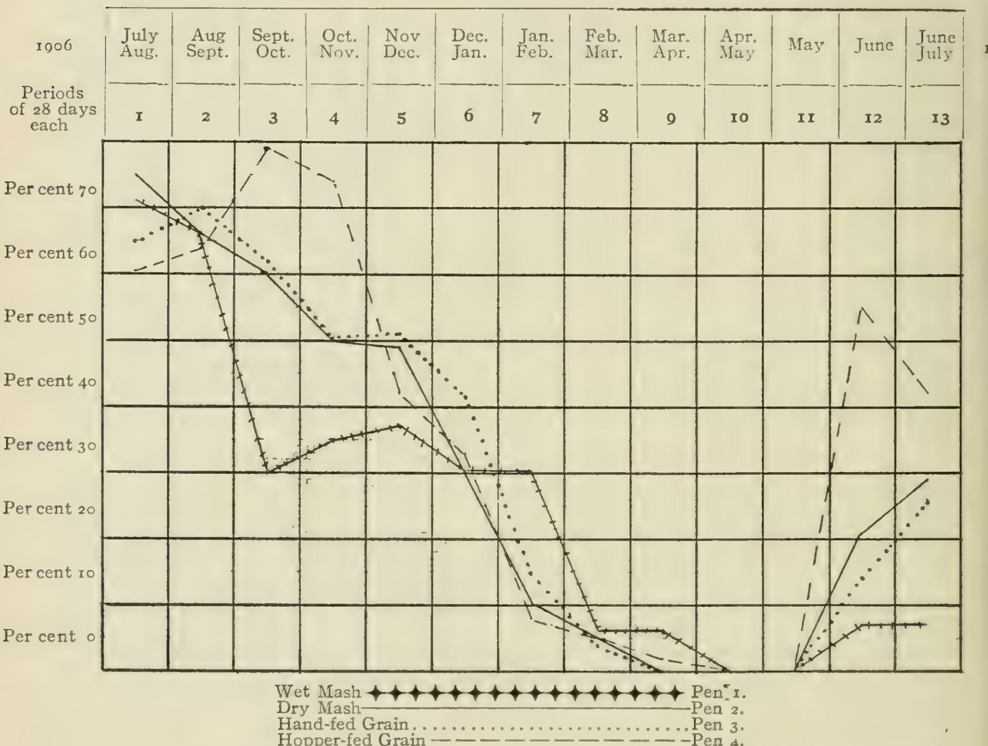


FIG. 127.—*Methods of forcing and retarding. A comparison of molting.*

Notice that during the periods of greatest production there was the least molting and that the heaviest molt followed the period of the heaviest laying.

Influence of early egg production and prolificacy on molt. Table 16.

In every pen except the hand-fed grain pen, the hens laying earliest molted less than those laying last. In every pen but the hopper-fed grain pen the most prolific hens molted twelve to sixteen days less than the least prolific hens.

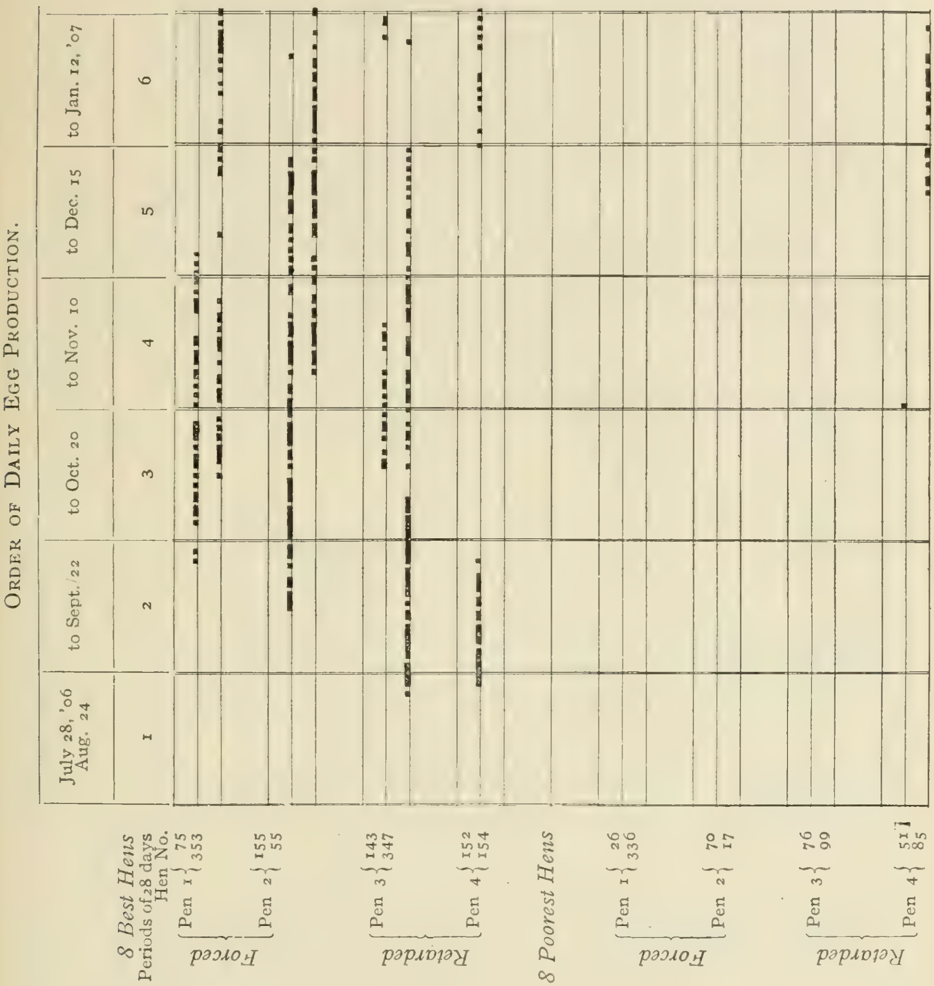


FIG. 128.—*A record of daily production.*

High production in pullets retards the first mature molt.

Of the six best layers from each of the four pens, numbering twenty-four hens, all but two were laying when the experiment closed, and four (16.6 per cent.) were molting. Of these four, two were losing just a few feathers; only two (8.3 per cent.) were in heavy molt. In other words the best producers molted last.

Broodiness.

There was no broodiness among the wet mash and grain fed hens; and only one hen, causing a loss of three days, among the dry mash and

grain fed hens. The hand-fed grain hens lost seventeen days on account of six broody hens, while the hopper-fed grain hens lost six days because of broodiness of two hens. Two-thirds of the entire loss from this cause was due to the hand-fed grain hens.

Daily egg production.

Each hen seemed to have some peculiarity in the matter of daily production. Some hens laid every other day. Others laid two or three days and then missed a day. In two or three cases a hen would occasionally lay two eggs in one day, but producing none on the following day. Fig. 128 shows a chart of daily production of the best two and poorest two layers in each pen. The little black squares show a single day's production. A longer solid line represents several days in succession, the open spaces indicating the intervals when the hen did not lay.

Mortality.

The mortality in the wet mash and grain fed pen and hopper-fed grain pen was extremely high, while that of the other pens was about normal. (Table 23.) In the hand-fed grain pen, two hens died early in the experiment, while in the hopper-fed grain pen, the deaths came at a later period. The only mortality in the dry mash and grain fed pen was near the close of the year, and was evidently the result of accident.

The immediate cause of the great mortality in the wet mash and grain fed pen and hopper-fed grain pen was eversion of the oviduct. Why these pens should have suffered more than the other pens in this respect is not known. Two hens, which were removed from the wet mash and grain fed pen because of this difficulty, recovered after being fed for a time on lighter food, though still having a wet mash.

At the same rate of mortality in flocks of 100 hens, 95 would remain of the dry mash and grain fed hens, and only 70 of the wet mash and grain fed hens, 90 of the hand-fed grain hens and 70 of the hopper-fed grain hens.

Profit per hen. (Table 25.)

The dry mash and grain fed flock made the best profit, $1.45 per hen, and the wet mash and grain fed flock came next with $1.34 per hen. This gives an excess of profit of eleven cents per hen in favor of the dry mash and grain method of feeding. For 100 hens this would be $11. This excess of profit is largely due to the greater loss by mortality in the wet mash and grain fed pens.

This profit does not, however, include the value of the hens still remaining. In the dry mash and grain fed pen there were 19 hens weigh-

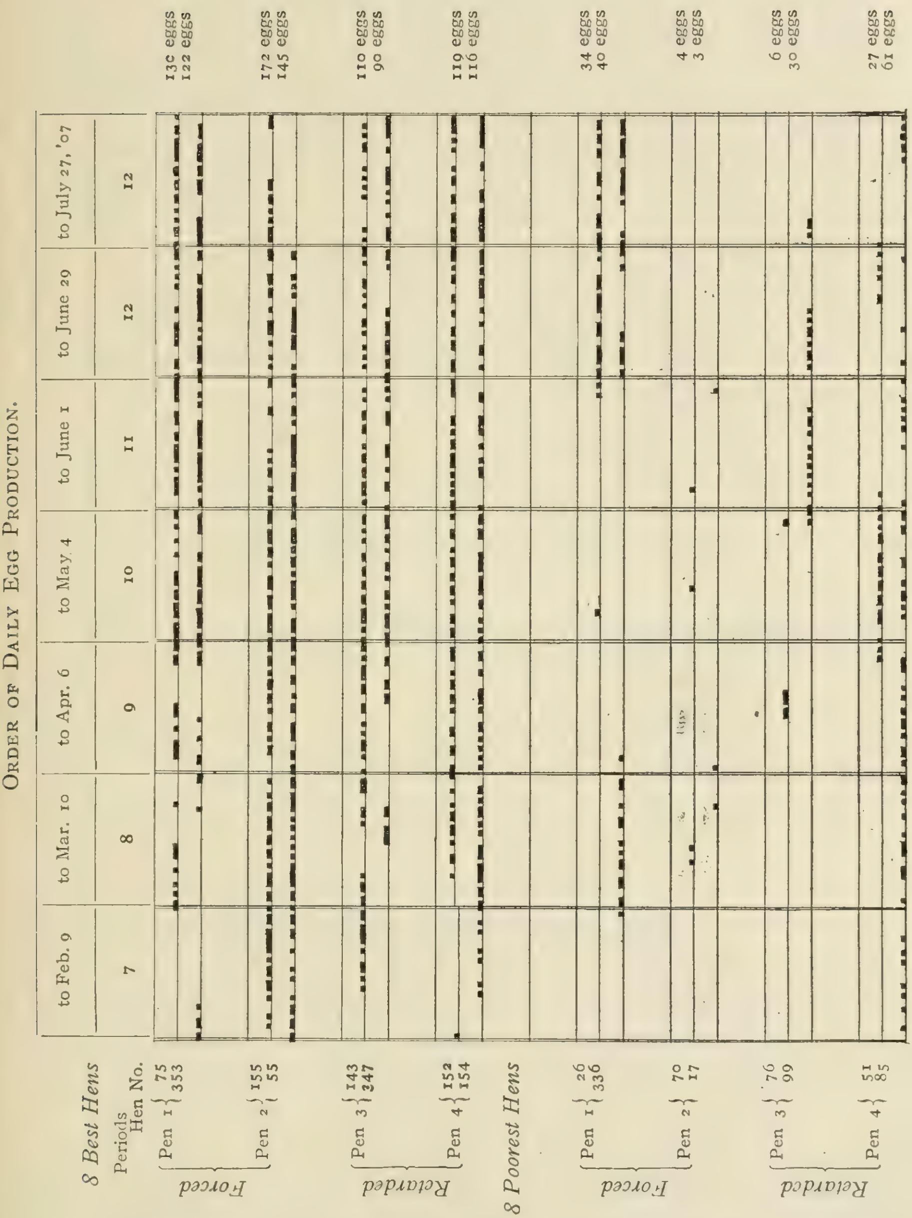


FIG. 128.—*A record of daily production, continued from page 311.*

ing 66.4 pounds, worth for meat, at least 12 cents per pound live weight, or $7.96. Of the wet mash and grain fed hens only 14 still remained, weighing 49.9 pounds. At the same value per pound, these hens were worth $5.98. This gives a further value of $1.98, or ten cents per hen, for the dry mash and grain method. For 100 hens this would be $10, or a total of $21 for 100 hens=21 cents per hen.

A comparison of the percentages (Fig. 129) shows that the dry mash and grain gave a greater per cent. in egg production, hatchability of eggs, gain in weight, and profit per hen, together with less mortality. Wet mash and grain gave slightly better fertility of eggs.

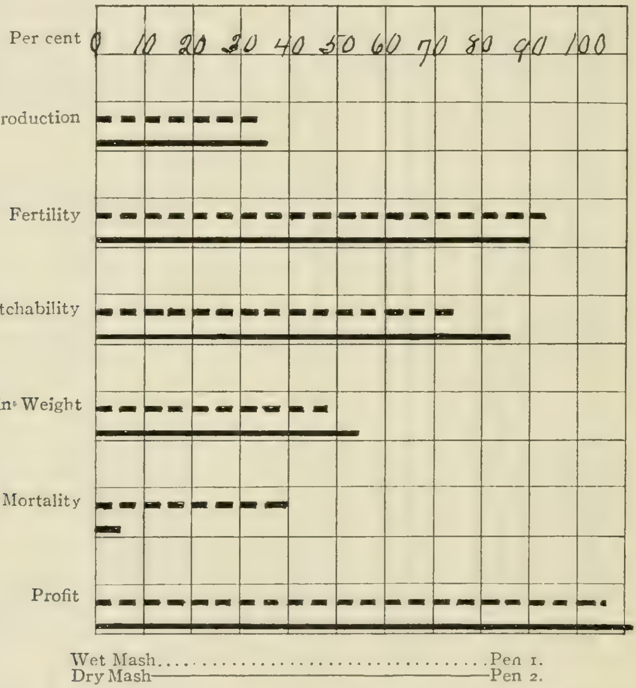


FIG. 129.—*Methods of forcing.—A comparison of wet and dry mash.*

A reference to Table 25 will show that the per cent. profit means the per cent. of gain calculated on the excess of income over cost of food.

Vices.

The hens which received whole grain and beef-scrap developed bad habits. The hand-fed hens wasted grit and shell by pulling it out of the boxes. They seemed to be looking for something they did not get, especially during March and April, when they were coming into heavy production.

The hopper-fed grain hens displayed the more serious fault of egg eating. This also was most noticeable during March and April. As a means of checking the habit, the hens were fed three ounces apiece of beef-suet, and no more eggs were eaten for ten days. Then the habit was again noticed, and eight ounces per hen of beef-suet was given them. The egg eating disappeared in a day or two, and the hens ate no more eggs till the last period of the experiment. Then only a few were eaten.

SUMMARY OF FINDINGS. PART I AND PART II.

The findings drawn from the data of this experiment are as follows, but they should in no case be accepted as final until verified by repeated experiments with vastly more fowls:

1. Forced pullets made a better profit than retarded pullets.
2. Forced pullets ate less food per hen at less cost per hen than retarded pullets.
3. Forced pullets produced more eggs of a larger size, at less cost per dozen than retarded pullets.
4. Forced pullets produced more eggs during early winter than retarded pullets.
5. Forced pullets gave better hatching results of eggs than retarded pullets.
6. Forced pullets made a greater percentage of gain in weight than retarded pullets.
7. Forced pullets showed less broodiness than retarded pullets.
8. Forced pullets had less mortality than retarded pullets.
9. Forced pullets showed better vigor than retarded pullets.
10. Forced pullets showed the first mature molt earlier than retarded pullets.
11. Retarded pullets gave better fertility of eggs than forced pullets.
12. Hopper-fed dry mash gave better results in gain of weight, production of eggs, gain in weight of eggs, hatching power of eggs, days lost in molting, mortality, health and profit per hen, than wet mash.
13. Wet mash and grain fed pullets consumed slightly less food at less cost, and produced eggs at slightly less cost per dozen than dry mash and grain fed pullets.
14. Wet mash and grain fed pullets produced slightly larger eggs of slightly better fertility, and showed less broodiness than dry mash and grain fed pullets.
15. Dry mash and grain fed pullets laid eggs of good size at an earlier period than wet mash and grain fed pullets.
16. Hopper-fed pullets ate more than hand-fed pullets.

17. Pullets having whole grain ate more grit and shell than those having a proportion of ground grain.

18. Pullets fed on grain were more inclined to develop bad habits than those having a mash.

19. Earliest producers did not give as many eggs in early winter.

20. Early layers gained as rapidly in weight as those beginning later to lay.

21. Prolificacy made but slight difference in weight of hen and weight of egg.

22. The most prolific pullets did not always lay earliest.

23. Pullets did not as a rule lay while molting.

SUPPLEMENT TO BULLETIN 249.

PEN 1. GAIN OR LOSS IN WEIGHT PER HEN, MORTALITY AND MOLT FOR EACH PERIOD OF 28 DAYS. TABLE I.

Period.	Dates.	Av. No. Hens in Pen.	Total wt. at beginning of Period.	Av. per Hen.	Gain in wt. during Period.	Value Gain.	Av. Gain per Hen.	Loss of Wt.	Value Loss.	Av. Loss per Hen.	Cost Food per Hen.	Cost per 100 Hens.	Broody.	Days Lost.	Mortality.	% Molting.	% which Gained in Wt.	% which Lost in Wt.	Value Loss. Stock.	
1	July 28 – Aug. 24	19	45.6	2.4	11.5	1.39	.7				.047	4.70			2	71	100%		.68	
2	Aug. 25 – Sep. 21	18	52.5	2.9	5.1	.61	.28				.064	6.40				66	72	22		
3	Sep. 22 – Oct. 19	16.6	55.5	3.2	1.05	.126	.06				.093	9.30			2	30	36	36	.436	
4	Oct. 20 – Nov. 15	16	55.5	3.47	2.	.24	.12				.072	7.20				35	68	25		
5	Nov. 16 – Dec. 14	16	57.5	3.6				.8	.096	.006	.07	7.00				37	31	31		Male in pen
6	Dec. 15 – Jan. 11	16	56.7	3.54	2.6	.312	.18				.074	7.40				30	75	25		
7	Jan. 12 – Feb. 9	16	59.3	3.7	2.6	.312	.18				.078	7.80				30	62.4	18.7		
8	Feb. 10 – Mar. 9	16	61.9	3.87				2.7	.324	.168	.08	8.00				6	18.7	81.3		
9	Mar. 10 – Apr. 5	16	59.2	3.7				1.8	.216	.112	.103	10.30				6	31	69		
10	Apr. 6 – May 3	16	57.4	3.93	2.3	.276	.14				.103	10.30					68.7	6		
11	May 4 – May 31	16	59.7	3.73				1.2	.44	.075	.105	10.50			1		18	62		
12	June 1 – June 28	14.5	54.6	3.64				.5	.06	.03	.107	10.70			1	7	35	42.8	.468	
13	June 29 – July 27	14	50.7	3.62				.8	.096	.05	.098	9.80				7.1	33	50	.508	
	Final Wt.		49.9	3.56																Male out
		16.1	55.5	3.44	27.15	3.266	1.66	7.8	1.236	.441	1.11	111.00			6	29.5	49.8	36.	2.108	

PEN 1. THE AMOUNT, KIND AND VALUE OF FOOD CONSUMED PER PERIOD OF 28 DAYS. TABLE II.

Period.	Dates.	Corn Meal.	Wheat Bran.	Wheat Midds.	Alfalfa Meal.	Meat Scrap.	Corn.	Wheat.	Oats.	Buckwheat.	Beets.	Green Bone.	Total Food.	Value Food.	Shell.	Grit.
1	July 28 – Aug. 24	3.8	1.9	3.8	1.9	3.8	15.4	15.4	15.4				61.5	.90	.6	1.2
2	Aug. 25 – Sep. 21	5.8	2.8	5.8	2.8	5.8	11.3	26.2	14.6				75.1	1.158	1.6	2.0
3	Sep. 22 – Oct. 19	6.3	3.2	6.3	3.2	6.3	24.	40.7	11.0				101.0	1.544	1.8	1.5
4	Oct. 20 – Nov. 15	4	2	4	2	4	23.8	30.6	7.6				78.0	1.156	1.0	.8
5	Nov. 16 – Dec. 14	5.3	2.6	5.3	2.6	5.3	25.1	25.0	5.2				76.4	1.131	.3	1.8
6	Dec. 15 – Jan. 11	5.8	2.8	5.8	2.8	5.8	28.6	20.9	8.6		30.0		111.1	1.27	2.2	5.2
7	Jan. 12 – Feb. 9	5.8	3.1	5.8	3.1	5.8	24.5	24.7	7.7	6	17.2	1.3	105.	1.388	2.1	2.9
8	Feb. 10 – Mar. 9	3.5	1.9	3.5	1.9	3.5	33.5	27.0	10.0	4.5	20.8		110.1	1.361	2.4	4.7
9	Mar. 10 – Apr. 5	9.8	5.4	9.8	5.4	9.8	40.2	22.2	8.3	1.1			112.0	1.648	3.4	2.6
10	Apr. 6 – May 3	6.9	3.4	6.9	3.4	6.9	39.1	37.5	9.9				114.0	1.753	5.7	3.3
11	May 4 – May 31	5.8	3.1	5.8	3.1	5.8	28.8	46.3	10.6				109.3	1.694	4.4	1.0
12	June 1 – June 28	7.3	3.6	7.3	3.6	7.3	27.0	36.0	10.0				102.1	1.559	4.0	1.3
13	June 29 – July 27	5.5	2 9	5.5	2.9	5.5	26.2	34.7	9.5				92.7	1.381	3.5	.2
	Total	75.6	38.7	75.6	38.7	75.6	347.5	387.2	128.4	11.6	68.0	1.3	1244.6	17.893	33.	28.5

Pen 1. Number and Weight of Eggs and Hatchability of Eggs per Period of 28 Days. Table III.

Period.	Dates.	Total No. Eggs Laid.	Total Dozens of Eggs.	% of Egg Production.	Av. Wt. per Egg. in. oz	No. of Eggs per Hen.	Av. Value of Eggs per Hen.	No. of Eggs per 100 Hens.	Value of Eggs per 100 Hens.	Cost per doz. Eggs.	No. Eggs Incubated.	% of Fertile Eggs.	% Fertile Eggs Hatched	Total Value Eggs.	Market Price of Eggs.
1	July 28 Aug. 24	12	1	2		.6	.006	60	.60	.90				.12	.12
2	Aug. 25 Sep. 21	67	$5\frac{7}{12}$	13	1.8	3.7	.04	370	4.00	.20				.72	.13
3	Sep. 22 Oct. 19	89	$7\frac{5}{12}$	19.1	1.8	5.3	.06	530	6.00	.20				1.01	.13
4	Oct. 20 Nov. 15	64	$5\frac{4}{12}$	14.2	1.84	4	.129	400	12.99	.216				2.07	.417
5	Nov. 16 Dec. 14	64	$5\frac{4}{12}$	14.2	1.9	4	.141	400	14.10	.209				2.275	.427
6	Dec. 15 Jan. 11	73	$6\frac{1}{12}$	16.2	2	4.5	.157	450	15.70	.208				2.51	.42
7	Jan. 12 Feb. 9	72	6	16	1.98	4.5	.14	450	14.00	.229				2.25	.39
8	Feb. 10 Mar. 9	188	$15\frac{9}{12}$	41.9		11.7	.285	1170	28.50	.086				4.56	.29
9	Mar. 10 Apr. 5	258	$21\frac{1}{2}$	57.5		16.1	.295	1610	29.50	.075	52	82.6	79	4.72	.22
10	Apr. 6 May 3	295	$24\frac{7}{12}$	65.8	2.06	18.6	.301	1860	30.10	.071	105	98.1	70	4.82	.20
11	May 4 May 31	298	$24\frac{10}{12}$	66.5		18.6	.337	1860	33.70	.068				5.40	.219
12	June 1 June 28	245	$20\frac{1}{4}$	60.3		17	.31	1700	31.00	.071				4.47	.22
13	June 29 July 27	230	$19\frac{1}{6}$	58.6	2.07	16.7	.275	1670	27.50	.072				3.85	.22
	Total	1955	$162\frac{11}{12}$	33.3	1.93	121.4	2.36	12140	236.00	.109	157	92.9	73.2	38.77	.261

PEN 2. GAIN OR LOSS IN WEIGHT PER HEN, MORTALITY AND MOLT FOR EACH PERIOD OF 28 DAYS. TABLE IV.

Period.	Dates.	Av. No. in Pen.	Total Wt. at beginning of Period.	Av. Weight per Hen.	Gain in Wt. during Period.	Value Gain.	Average Gain per Hen.	Loss of Wt.	Value of Loss in Weight.	Av. Loss in Weight per Hen.	Cost of Food per Hen.	Cost per 100 Hens.	Broody.	Days Lost.	Mortality.	% Molting.	% which Gained in Wt.	% which Lost in Wt.	Value of Loss of Stock.	
1	July 28 – Aug. 24	20	45.2	2.26	6.5	.78	.32				.061	6.10				75	90	10		
2	Aug. 25 – Sep. 21	20	51.7	2.58	8.3	.996	.41				.078	7.80				66	95	5		
3	Sep. 22 – Oct. 19	20	60	3	8.9	1.068	.44				.075	7.50				60	90	10		
4	Oct. 20 – Nov. 15	20	68.9	3.45				.1	.012		.089	8.90				50	45	45		
5	Nov. 16 – Dec. 14	20	68.8	3.45	2.25	.27	.11				.073	7.30				49	65	25		
6	Dec. 15 – Jan. 11	20	71.0	3.55	1.2	.144	.06				.095	9.50				41	60	35		Male in pen
7	Jan. 12 – Feb. 9	20	72.2	3.61	3.3	.396	.16				.103	10.30				10	30	45		
8	Feb. 10 – Mar. 9	20	75.5	3.77				.4	.048	.02	.091	9.10				5		100		
9	Mar. 10 – Apr. 5	20	75.1	3.75				4.0	.48	.2	.085	8.50					40	35		
10	Apr. 6 – May 3	20	71.1	3.55				.1	.012	.005	.10	10.00					40	35		
11	May 4 – May 31	20	71.0	3.55				2.5	.30	.12	.13	13.00					20	60		
12	June 1 – June 28	19	68.5	3.37				1.4	.168	.07	.104	10.40	1	3	1	21	57	31	.42	
13	June 29 – July 27	19	64.0	3.34				1.8	.216	.9	.101	10.10				20	42	42		Male out
	Final Wt.		66.5	3.5																
		19.8	66.4	3.33	30.45	3.654	1.5	10.3	1.230	1.315	1.23	123.00	1	3	1	40	50.5	36.7	.420	

Pen 2. Amount, Kind and Value of Food Consumed per Period of 28 Days. Table V.

Period.	Dates.	Corn Meal.	Wheat Bran.	Wheat Midds.	Alfalfa Meal.	Meat Scrap.	Corn.	Wheat.	Oats.	Buckwheat.	Beets.	Green Bone.	Peas.	Total Food.	Value Food.	Shell.	Grit.
1	July 28 Aug. 24	10	5	10	5	10	16	16	16					88.2	1.239	2	1.9
2	Aug. 25 Sep. 21	8.8	4.4	8.8	4.4	8.8	16.1	35.1	15					101.4	1.568	2.7	1.5
3	Sep. 22 Oct. 19	11.8	5.8	11.8	5.8	11.8	21.2	24.1	7.8					100.1	1.512	2.3	1.1
4	Oct. 20 Nov 15.	11.5	5.7	11.5	5.7	11.5	26.9	36.0	9.0					117.8	1.781	2.6	.9
5	Nov. 16 Dec. 14	10.3	5.1	10.3	5.1	10.3	32.5	31.2	5.8					110.6	1.537	1.4	3.0
6	Dec. 15 Jan. 11	16.0	7.9	16.0	7.9	16.0	31.9	24.1	7.9					127.7	2.001	3.6	1.8
7	Jan. 12 Feb. 9	17	8.5	17	8.5	17	29.6	27.1	9.1	6.5	24.5	2.0		166.8	2.168	2.1	2.2
8	Feb. 10 Mar. 9	12.8	6.4	12.8	6.4	12.8	34.2	25.5	8.6	3.1	20.0	3.5	.9	147.0	.917	6.0	2.5
9	Mar. 10 Apr. 5	10.6	6.4	10.6	4.2	10.6	42.3	25.5	8.5	2.5			3.9	125.1	1.810	2.5	3.9
10	Apr. 6 May 3	11.0	5.5	11.0	5.5	11.0	45.6	40.5	10.8					140.9	2.106	4.1	.8
11	May 4 May 31	21.0	10.5	21.0	10.5	21.0	33.0	49.0	12.0					178.0	2.738	5.2	5.4
12	June 1 June 28	12.6	6.4	12.6	6.4	12.6	32.4	42.3	10.8					130.1	2.083	4.5	1.3
13	June 29 July 27	11.6	5.8	11.6	5.8	11.6	29.9	40.5	10.6					127.4	1.927	3.3	.3
	Total	165.0	83.4	165.0	81.2	165.	391.6	416.9	136.9	12.1	44.5	5.5	4.8	1666.9	24.387	42.3	26.3

PEN 2. NUMBER, WEIGHT AND VALUE OF EGGS AND HATCHABILITY OF EGGS DURING EACH PERIOD OF 28 DAYS. TABLE VI.

Period.	Dates.	Total No. Eggs Laid.	Total Dozens of Eggs.	% Egg Production.	Av. Wt. per Egg. in oz.	Eggs per Hen.	Av. Value of Eggs per Hen.	No. of Eggs per 100 Hens.	Value Eggs per 100 Hens.	Cost per Doz. Eggs.	Eggs Incubated.	% Fertile Eggs.	% Fert. Eggs Hatched	Value Eggs.	Market Price of Eggs
1	July 28 Aug. 24	74	2 1/2	13.2		1.5	.015	150	1.50	.49				.74	.12
2	Aug. 25 Sep. 21	151	12 7/12	27.	1.7	7.5	.081	750	8.10	.123				1.63	.13
3	Sep. 22 Oct. 19	98	8 2/12	17.1	1.7	4.9	.063	490	6.30	.18				1.26	.13
4	Oct. 20 Nov. 15	112	9 1/3	20	2.02	5.6	.188	560	18.80	.19				3.77	.417
5	Nov. 16 Dec. 14	63	5 1/4	11.3	1.9	3.1	.113	310	11.30	.29				2.26	.427
6	Dec. 15 Jan. 11	127	10 7/12	22.5	2.03	6.3	.208	630	20.80	.189				4.16	.42
7	Jan. 12 Feb. 9	118	9 10/12	21	2.06	5.9	.164	590	16.40	.212				3.29	.39
8	Feb. 10 Mar. 9	252	21	45		12.6	.30	1260	30.00	.091				6.02	.29
9	Mar. 10 Apr. 5	340	28 1/3	60		17	.309	1700	30.90	.064	90	90.4	88.5	6.19	.22
10	Apr. 6 May 3	353	28 1/12	63	2.04	17.6	.286	1760	28.60	.074	124	89.6	87.9	5.73	.20
11	May 4 May 31	357	30 7/12	65.5		18.3	.33	1830	33.00	.089				6.61	.219
12	June 1 June 28	299	24 11/12	53.2		14.9	.273	1490	27.30	.086				5.46	.22
13	June 29 July 27	207	17 1/4	38.9	1.96	10.8	.206	1080	20.60	.071				3.92	.22
	Total	2561	213 5/12	35.5	1.92	129.3	2.57	12930	257.00	.114	214	91.0	84.7	51.04	.261

PEN 3. GAIN OR LOSS IN WEIGHT PER HEN, MORTALITY AND MOLT FOR EACH PERIOD OF 28 DAYS. TABLE VII.

Period.	Dates.	Av. No. in Pen.	Total Wt. at beginning of Period.	Av. Weight per Hen.	Gain in Wt. during Period.	Value Gain.	Av. Gain per Hen.	Loss of Wt.	Value Loss of Weight.	Av. Loss in Weight per Hen.	Cost Food per Hen.	Cost per 100 Hens.	Broody.	Days Lost.	Mortality.	% Molting.	% which Gained in Wt.	% w'ich Lost in Wt.	Value of Loss of Stock.
1	July 28 – Aug. 24	19	49.9	2.49	10.5	1.26	.55				.052	5.20			1	60	94.8	5.2	.402
2	Aug. 25 – Sep. 21	19	57.0	3	.6	.072	.03				.072	7.20				64.1	73.6	26.4	
3	Sep. 22 – Oct. 19	19	57.6	3	1.5	.18	.07				.071	7.10	1	2		78.9	53.8	26.3	
4	Oct. 20 – Nov. 15	19	59.1	3.1	4.1	.492	.21				.076	7.60				73.7	78.9 Male	15 in pen	
5	Nov. 16 – Dec. 14	18.9	62.2	3.27	1.8	.216	.1				.061	6.10			1	42	37.	26.4	.384
6	Dec. 15 – Jan. 11	18	61.8	3.43	.8	.096	.04				.081	8.10				33	38.8	50	
7	Jan. 12 – Feb. 9	18	63.5	3.52	1.7	.204	.09				.081	8.10				8.3	50	33	
8	Feb. 10 – Mar. 9	18	65.2	3.62				3.1	.372	.17	.074	7.40				5.0	16	72	
9	Mar. 10 – Apr. 5	18	62.1	3.45				3.2	.384	.17	.094	9.40					16	66	
10	Apr. 6 – May 3	18	59.9	3.32				.2	.024	.01	.094	9.40					50	44	
11	May 4 – May 31	18	59.7	3.24				1.4	.168	.07	.101	10.10					16	61	
12	June 1 – June 28	18	58.3	3.23				1.6	.192	.08	.092	9.20				55	27 Male	72 out	
13	June 29 – July 27	18	56.7	3.15				.4	.048	.02	.071	7.10	6	17		42	33	44	
	Final Wt.		56.3	3.13															
		18.3	59.2	3.21	21.0	2.52	1.09	9.9	1.188	.52	1.10	110.00	7	19	2	46.2	44.9	41.6	.786

PEN 3. AMOUNT, KIND AND VALUE OF FOOD CONSUMED PER PERIOD OF 28 DAYS. TABLE VIII.

Period.	Dates.	Corn Meal.	Wheat Bran.	Wheat Midds.	Alfalfa Meal.	Meat Scrap.	Corn.	Wheat.	Oats.	Buckwheat.	Beets.	Green Bone.	Peas.	Total Food.	Shell.	Grit.	Value Food.
1	July 28 Aug. 24					3.6	23.4	23.4	23.4					73.8	2.7	5.7	1.10
2	Aug. 25 Sep. 21					6.0	19.2	39.9	22.8					87.9	.9		1.386
3	Sep. 22 Oct. 19					2.8	27.1	42.3	13.0					85.2	5.5	6.8	1.357
4	Oct. 20 Nov. 15					5.5	33.9	43.7	11.5					94.6	1.4	.8	1.453
5	Nov. 16 Dec. 14					3.7	34.2	34.1	6.5		2.0			78.5	3.0	10.8	1.226
6	Dec. 15 Jan. 11					10.8	41.8	31.2	10.3		22.8			116.9	1.7	9.0	1.545
7	Jan. 12 Feb. 9					6.4	35.2	27.1	12.0	10.8	17.6	1.1		110.2	2.7	3.8	1.547
8	Feb. 10 Mar. 9					5.9	58.5	37.5	14.2	3.7	14.0	2.5	1.5	137.8	5.0	5.5	1.416
9	Mar. 10 Apr. 5					5.5	59.0	34.5	13.5	1.5			4.5	118.5	12.7	4.0	1.802
10	Apr. 6 May 3					7.7	53.0	49.0	13.2					123.1	3.8	1.7	1.801
11	May 4 May 31					8.8	41.5	59.5	14.8					124.6	4.2	1.2	1.938
12	June 1 June 28					5.4	41.5	54.0	13.5					114.5	5.8	.8	1.757
13	June 29 July 27					4.6	29.3	39.1	9.8					82.8	3.1	3.2	1.294
	Total					76.7	497.6	515.0	177.4	16	56.4	3.6	6.0	1348.4	52.5	53.3	19.620

PEN 3. NUMBER, WEIGHT AND VALUE OF EGGS AND HATCHABILITY OF EGGS FOR EACH PERIOD OF 28 DAYS. TABLE IX.

Period.	Dates.	Total No. Eggs Laid.	Total Dozens of Eggs.	% Egg Production.	Av. Wt. per Egg in oz.	Eggs per Hen.	Av. Value of Eggs per Hen.	No. of Eggs per 100 Hens.	Value of Eggs per 100 Hens.	Cost per doz. Eggs.	Eggs Incubated.	% Fertile Eggs.	% Fert. Eggs Hatched	Value Eggs.	Av. Market Price of Eggs.
1	July 28 Aug. 24	44	$3\frac{8}{12}$	8.2		2.31	.023	231	2.30	.33				.44	.12
2	Aug. 25 Sep. 21	105	$8\frac{9}{12}$	19.7	1.9	5.5	.059	350	5.90	.15				1.13	.13
3	Sep. 22 Oct. 19	49	$4\frac{1}{12}$	9.2	1.7	2.57	.028	257	2.80	.33				.54	.13
4	Oct. 20 Nov. 15	34	$2\frac{10}{12}$	6.4	1.8	1.78	.056	178	5.60	.578				1.08	.417
5	Nov. 16 Dec. 14	61	$5\frac{1}{12}$	11.5	1.79	3.22	.108	322	10.80	.239				2.07	.427
6	Dec. 15 Jan. 11	54	$4\frac{1}{2}$	10.3	1.98	3	.106	300	10.60	.343				1.928	.42
7	Jan. 12 Feb. 9	125	$10\frac{5}{12}$	24.7	2.12	6.94	.226	694	22.60	.148				4.17	.39
8	Feb. 10 Mar. 9	185	$15\frac{5}{12}$	36.7		10.27	.251	1027	25.10	.092				4.53	.29
9	Mar. 10 Apr. 5	266	$22\frac{1}{6}$	52.7		14.77	.267	1477	26.70	.081	97	94.8	76.8	4.82	.22
10	Apr. 6 May 3	290	$24\frac{1}{6}$	57.5	2.06	16.11	.267	1611	26.70	.074	60	91.6	69	4.83	.20
11	May 4 May 31	321	$26\frac{9}{12}$	63.6		17.83	.321	1783	32.10	.072				5.78	.219
12	June 1 June 28	271	$22\frac{7}{12}$	53.7		15	.274	1500	25.46	.078				4.94	.22
13	June 29 July 27	162	$13\frac{1}{2}$	32.1	1.96	9	.155	900	15.50	.094				2.79	.22
	Total	1967	$163\frac{11}{12}$	30.5	19.1	110.7	1.57	11070	157.00	.119	157	93.6	78.2	39.040	.261

PEN 4. GAIN OR LOSS IN WEIGHT PER HEN, MORTALITY AND MOLT FOR EACH PERIOD OF 28 DAYS TABLE X.

Period.	Dates.	Av. No. in Pen.	Total Wt. at beginning of Period.	Av. Weight per Hen.	Gain in Wt. during Period.	Value Gain.	Av. Gain per Hen.	Loss Wt.	Value Loss of Weight.	Av. Loss per Hen.	Cost Food per Hen.	Cost per 100 Hens.	Broody.	Days Lost.	Mortality.	% Molting.	% which Gained in Wt.	% which Lost in Wt.	Value of Loss of Stock.
1	July 28 Aug. 24	20	47.7	2.38	16.4	1.974	.82				.066	6.60				65	100		
2	Aug. 25 Sep. 21	20	64.1	3.2	1.45	.174	.07				.072	7.20				70	50	40	
3	Sep. 22 Oct. 19	20	65.6	3.2				1.25	.15	.06	.072	7.20				62	35	60	
4	Oct. 20 Nov. 15	20	64.3	3.2	4.85	.582	.24				.087	8.70				50	75 Male	15 in pen	
5	Nov. 16 Dec. 14	19.3	69.2	3.58	3.4	.40	.17				.092	9.20			1	51	75	15	.425
6	Dec. 15 Jan. 11	19	69.1	3.58	.3	.036					.095	9.50				42	57	31	
7	Jan. 12 Feb. 9	17.7	69.4	3.6	4.8	.516	.28				.108	10.80			2	16	64	17	.792
8	Feb. 10 Mar. 9	17	67.6	3.9				3.4	.408	.2	.13	13.00				29	6	76	
9	Mar. 10 Apr. 5	17	64.2	3.76				1.6	.192	.09	.129	12.90					23	52	
10	Apr. 6 May 3	17	62.6	3.68	1.3	.076	1.56				.116	11.60			1		56	37	.525
11	May 4 May 31	15.9	59.5	3.44	.4	.048	.02				.105	10.50			1		40	33	.396
12	June 1 June 28	14.5	56.6	3.77				2.1	.252	.15	.10	10.00			1	14	13 Male	64 Removed	.384
13	June 29 July 27	14	51.3	3.66				1.2	.144	.1	.091	9.10	2	6		26	7	78	
	Final Wt.		50.1	3.58															
		17.7		3.46	32.9	3.806	3.16	9.55	1.146	.60	1.31	131.00	2	6	6	42.5	46.2	43.1	2.522

PEN 4. AMOUNT, KIND AND VALUE OF FOOD CONSUMED FOR EACH PERIOD OF 28 DAYS. TABLE XI.

Period.	Dates.	Corn Meal.	Wheat Bran.	Wheat idds.	Alfalfa Meal.	Meat Scrap.	Corn.	Wheat.	Oats.	Buckwheat.	Beets.	Green Bone.	Peas.	Total Food.	Shell.	Grit.	Value Food.
1	July 28 – Aug. 24					3.4	29.1	29.1	29.1					90.7	1.9	3.3	1.339
2	Aug. 25 – Sep. 21					3.3	23.9	50.4	14.4					92.0	2.3	1.2	1.448
3	Sep. 22 – Oct. 19					5.8	29.3	46.0	13.1					94.2	1.0	.8	1.455
4	Oct. 20 – Nov. 15					6.1	40.8	62.5	13.7					114.1	1.5	4.6	1.759
5	Nov. 16 – Dec. 14					6.8	54.7	52.5	8.9		4.5			127.4	1.4	2.2	1.878
6	Dec. 15 – Jan. 11					8.9	54.2	49.7	13.5		3.5			129.8	1.4	.6	1.903
7	Jan. 12 – Feb. 9					1.0	54.4	51.3	16.5	12.7	22.7	1.5		160.1	3.1	1.6	2.026
8	Feb. 10 – Mar. 9					6.9	73.5	54.0	17.8	6.7	21.9		4.1	183.9	4.1	1.0	2.356
9	Mar. 10 – Apr. 5					6.2	83.7	47.7	18.6	2.7			7.8	166.7	6.0	2.7	2.331
10	Apr. 6 – May 3					9.2	50.8	56.0	18.					134	5.2	2.2	2.101
11	May 4 – May 31					6.9	36.7	57.0	13.3					113.9	3.1	1.0	1.783
12	June 1 – June 28					8.7	33.0	44.6	11.1					96.8	5.7	1.1	1.552
13	June 29 – July 27					5.6	28.6	31.7	9.4					75.3	3.2	.1	1.285
	Total					78.8	592.7	621.9	197.4	22.1	52.6	1.5	11.9	1578.9	39.9	22.4	23.265

PEN 4. NUMBER, WEIGHT AND VALUE OF EGGS AND HATCHABILITY OF EGGS FOR EACH PERIOD OF 28 DAYS. TABLE XII.

Period.	Dates.	Total No. Eggs Laid.	Total Dozens of Eggs.	% Egg Production.	Av. Wt. per Egg.	Eggs per Hen.	Av. Value of Eggs per Hen.	No. of Eggs per 100 Hens.	Value of Eggs per 100 Hens.	Cost per Doz. Eggs.	Eggs Incubated.	% Fertile Eggs.	% Fert. Eggs Hatched.	Value Eggs.	Av. Market Price of Eggs.
1	July 28 Aug. 24	31	$2\frac{7}{12}$	5.5		1.5	.015	150	1.50	.51				.31	.12
2	Aug. 25 Sep. 21	133	$11\frac{1}{12}$	23.7	1.67	6.2	.072	620	7.20	.13				1.44	.13
2	Sep. 22 Oct. 19	34	$2\frac{10}{12}$	6	1.73	1.6	.018	160	1.80	.52				.37	.13
4	Oct. 20 Nov. 15	31	$2\frac{7}{12}$	5.5	1.67	1.5	.052	150	5.20	.58				1.06	.417
5	Nov. 16 Dec. 14	52	$4\frac{4}{12}$	9.5	1.96	2.69	.096	269	9.60	.43				1.86	.427
6	Dec. 15 Jan. 11	109	$9\frac{1}{12}$	20.4	2.1	5.72	.198	572	19.80	.209				3.77	.42
7	Jan. 12 Feb. 9	81	$6\frac{9}{12}$	16.3	1.89	4.59	.142	459	14.20	.30				2.52	.39
8	Feb. 10 Mar. 9	188	$15\frac{8}{12}$	39.5		11	.266	1100	26.60	.15				4.54	.29
9	Mar. 10 Apr. 5	241	$20\frac{1}{12}$	50.6		14.1	.261	1410	21.10	.115	168	94.7	56.3	4.44	.22
10	Apr. 6 May 3	280	$23\frac{4}{12}$	58.8	2.05	16.4	.28	1640	28.00	.09	58	94.8	72.7	4.79	.20
11	May 4 May 31	279	$23\frac{3}{12}$	58.8		16.4	.317	1640	31.70	.075				5.05	.219
12	June 1 June 28	242	$20\frac{2}{12}$	59.6		16.7	.304	1670	30.40	.088				4.41	.22
13	June 29 July 27	203	$16\frac{10}{12}$	51.7	1.93	14.5	.267	1450	26.70	.074				3.75	.22
	Total	1904	$158\frac{8}{12}$	29.0	1.87	107.5	2.05	10750	205.00	.147	226	94.6	58.8	38.31	.261

CORNELL
Reading-Course for Farmers

PUBLISHED MONTHLY BY THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS JULY 16, 1894
L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING. | ITHACA, N. Y., NOVEMBER, 1906 | No. 31. CLUBS AND CORRESPONDENCE.

CLUBS AND CORRESPONDENCE.

By CHARLES H. TUCK, *Supervisor.*

Another season with its seed time and harvest has passed. The cold winds of the eleventh month warn us that 1906 has practically closed her accounts. On which side is the balance with us?

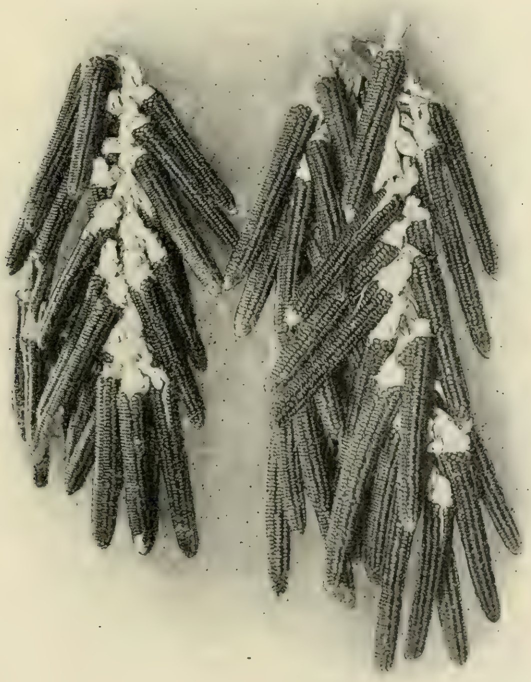


Photo by Morton.

Forced from the work in the fields to the shelter of the barns and the house, we cannot help but look back over the summer's work,—that summer that has exacted our very best efforts in the struggle to make things

meet or to get a little ahead. Many times we have felt with a sting of pain and discontent the necessity of our working hard in the sweltering heat of that summer while others loitered under cool inviting shade. But the winter is our time of thoughtful rest, if we will only take it.

Now that the harvesting is done, naturally revolving in our mind's eye the farm operations of the season past, we see mistakes here and defects there; but we are only strengthened by those mistakes. We look to the future hopefully, that we may improve on the past work. With many of us the winter, as well as the summer, presents problems of farm management, challenging our best efforts again. Let us face the situation directly and practically as each of us finds it. We will first weigh the farm problems presented by the summer and the winter strictly on their merits from a business point of view; and then we will consider the social life of our community in which we and our children are to work.

The silo has just been filled. The apples have just been picked, and the potatoes have just been dug. Have we grown and harvested those plants in the way that gave us the largest cash returns?

Good shelter for our stock must be provided for the winter. Proper food in propor proportions must be fed. Orchards must be looked after. Poultry will command more and more of our time. Accumulating manures must be economically saved. Do we know how to shelter and feed that stock, how to care for that orchard, how to feed that poultry, how to handle that manure in order to realize the greatest net returns on our time and our money invested? Practical books of a known value are available. Practical men of thorough experience are at hand. They may be right near us; our neighbors perhaps. It remains for us to reach those books and those men.

The Reading-Course for Farmers published at Cornell under state appropriation serves as a medium through which farmers, investigators and practical writers interchange thoughts and experiences. The old readers understand this. You, new readers, will understand it if you keep in touch with the work. But valuable as this practical knowledge will be, we feel that a little social intercourse, a little sympathetic exchange of ideas, in connection with our practical study, will make us better men. Especially do the young men feel the need of this.

No better way to express and to develop this feeling in a tangible way can be found than in meeting with one another in small numbers, occasionally, to learn to know our problems and ourselves. You do not need many in your party. Six to twelve interested members will be sufficient. Let some one send the names of those interested to the bureau for the bulletins desired on the preferred subject. Each one will carefully read over the first half of the bulletin. This will probably give

him new ideas and will recall many experiences of value. Meet by appointment at some convenient and desirable place. Have the Bulletin read paragraph by paragraph, stopping to criticise or to add wherever thought desirable. If there is only a small number you may then take up informally the questions on the accompanying Discussion-Paper dealing with the first half of the Bulletin. You will find at once many opinions advanced which will naturally consume much time in their expression. If there is a fair-sized number at your meeting, you will need some organization. One of your party on meeting will name a chairman who will receive nominations for the officers of the Club, a President, a Vice-President and a Secretary. The main duty of the President will be to start the discussion and to hold it on the point at issue. The Secretary will return Discussion-Papers, carry on the correspondence, secure the Bulletins and provide the Bureau with the names of the members, officers, and the name (where one is chosen) of the Club. The meeting should not be held so long as to be tiresome on the discussion of the Bulletin work. Let it be lightened with a charm of music and the spice of social pleasantry which makes the meetings of people in similar conditions so cheering. Meet regularly at least once in a fortnight. Spend two meetings on one Bulletin. Let me suggest that you think over the discussions and the next day write out, not simply short answers alone, but your views fully expressed on the Discussion-Paper. Bring samples of farm products to the meetings wherever possible.

Suggestions for the arrangement of the work for the winter may be received from the following program in actual use in one of the Clubs:

Jan.	9.	Installation of Officers.	
Jan.	23.	The Making of the Soil.	Bulletin 1.
Feb.	13.	Soil Fertility.	
Feb.	27.	Saving steps. Bulletin 1, Farmers' Wives.	
March	13.	Plant Foods.	Bulletin 3.
March	27.	Commercial Fertilizers.	
April	10.	The Kitchen Garden. Bulletin 4, Farmers' Wives.	
May	29.	Tillage.	Bulletin 2.
April	24.	Drainage.	
June	26.	The Flower Garden. Bulletin 5, Farmers' Wives.	
July	24.	How the Plant Gets Its Food from the Soil. Bulletin 4.	
Aug.	28.	How the Plant Gets Its Food from the Air. Bulletin 5.	
Sept.	25.	Decoration in the Farm Home. Bull. 2, Farmers' Wives.	
Oct.	23.	Marketing our Produce.	
Nov.	13.	Looking Backward.	
Nov.	27.	Practical Housekeeping. Bulletin 3, Farmers' Wives.	
Dec.	11.	Election of Officers.	

You will notice the alternation of the Bulletins of the Reading-Course for Farmers with those of the Reading-Course for Farmers' Wives, which means that the Club was composed of both men and women. This should prove highly desirable in that the discussions will interest all of the family. Definitely plan to follow up the work during the winter and as far into the summer as you can.

If some of the older farmers see that the young farmers are not getting interested, they should make it a special point to interest them. Perhaps the young men think the course is designed only for older men or for some other reason they feel that they are not wanted. If they feel this, they are laboring under a mistaken idea. Young men are especially desired to enter into the work and young men in many places are actually doing the work. Perhaps there are young men about you more desirous of taking up the work than you may be aware of. Here is a sample of such interest in Millerton, as shown by the following letter:

"THE SUMMIT STOCK FARM,
"MILLERTON, N. Y., *December* 13, 1905.

"*Reading-Course for Farmers, Ithaca, N. Y.:*

"Gentlemen.—I have organized a club of *young* farmers and are all anxious to take the READING-COURSE. There are ten of us at present, all willing to take the course of Dairying first. Will you kindly send me ten Bulletins and I will distribute them at our next meeting.

"Very respectfully,
"HERBERT EGGLESTON, *Pres.*"

This club has shown keen interest in the work since its formation. We believe this interest will continue. When possible, the Supervisor of the Reading-Course for Farmers will be very much pleased to visit such clubs in order that he may help in a more personal way.

Help us to reach and to know these young men. The life of our community and the maintenance of our local institutions depend, for the future, solely on our young men and women. Now is the time, our locality is the place, the Reading-Course for Farmers, the method, to help young farmers to appreciate the dignity of their work and the opportunities of their position.

Cornell men, having had instruction here in any of the courses in agriculture, should be most willing and efficient workers in this cause. Theirs is the duty and responsibility of sharing their point of view and their general agricultural information with others less fortunate in training. The College looks to them for help in this work.

The Grange, too, offers a medium through which the work may be effectively started. Its officers are in thorough sympathy with the Course. At some meeting, propose the matter of forming a club for the purpose of reading the Bulletins of the Reading-Course for Farmers; ask for the names of those interested, and call a meeting directly after the Grange meeting. Organize yourselves in the most convenient way. After a problem has been discussed in the club, it then may be presented to the Grange. You will be surprised to see how much you have gained by your study when you lay the problem before the Grange. On the Discussion-paper is a Roster that you are invited to fill out, giving the names of proposed members or remarks about your situation, or both.

The following letters indicate the kind of interest taken by many Granges:

WESTPORT, N. Y., *Oct.* 27, 1906.

"I have been appointed by Lake View Grange No. 970 to write you for bulletins for the following members. They wish to start with Bulletin No. 1 of the course. (The names of 22 readers followed.) We trust to derive much benefit from the course and are anxious to have the bulletins by the fifteenth of November."

"We are trying to start a Reading-Course Club in Leyden Grange. Would like you to send the Reading-Course for Farmers' Wives and Farmers." (The names of 23 women and 21 men followed.)

NUNDA, N. Y., *Oct.* 29, 1906.

"The Mindahua Grange at its last meeting unanimously voted to pursue the course concerning which I wrote you, beginning with Series I. We have 54 members. Please send the lessons in one package to me and I will distribute as each new lesson is taken up.

"We anticipate great pleasure as well as profit in the course."

In all, thirty Bulletins in the Farmers' Reading-Course are published, dealing in order with the subjects named below:

"Series I. *The Soil and the Plant.* The Bulletins in this series are: (1) The Soil, What it is; (2) Tillage and Under-Drainage; (3) The Fertility of the Soil; (4) How the Plant Gets its Food from the Soil; (5) How the Plant Gets its Food from the Air.

"Series II. *Stock-Feeding.* The Bulletins in this series are: (6) Balanced Rations for Stock; (7) The Computing of Balanced Rations; (8) Sample Rations for Milch Cows; (9) Soiling Crops and Silage; (10) Pastures and Meadows.

"Series III. *Orcharding.* The Bulletins in this series are: (11) How a Fruit Tree Grows; (12) Planting the Orchard; (13) Tilling and Fertilizing the Orchard; (14) Pruning and Spraying Fruit Trees; (15) Picking, Storing and Marketing Fruit.

"Series IV. *Poultry.* The Bulletins in this series are: (16) Building Poultry Houses; (17) Feeding of Laying Hens; (18) Rations for Poultry; (19) Raising Chickens; (20) Marketing Poultry Products.

"Series V. *Dairying.* The Bulletins in this series are: (21) The care of Milk; (22) The Composition of Milk; (23) The Construction of Sanitary Dairy Stables; (24) Farm Butter-making; (25) The Dairy Herd.

"Series VI. *Farm Buildings and Yards.* The Bulletins in this series are: (26) Tasteful Farm Buildings; (27) Tasteful Farm Yards; (28) The Plan of the Farmhouse; (29) Water Supplies for Farm Residences; (30) Barns and Out-Buildings."

You may take up for study any one of these six series. You should finish at least one series this winter. When you have finished one series or all the series and wish to read further along the particular line studied, then we urge you to continue your work by securing the best books. We can recommend the best books and bulletins on the farm subjects in which you are interested. These the reader purchases himself and reads under our guidance. Study them carefully. If a reader desires to study more thoroughly, then he may make reports to us on these books from time to time. He may even be examined if he so desires. But at least, write out your opinions of the book, making any criticisms on principles or methods involved. You will find this helpful to you. It will be an indication to us that you are really working.

A good way to link the Reading-Course with the more advanced study in the Correspondence Course is to begin early to patronize the Traveling State Library. You may procure for 6 months' use, books from the Department of Public Instruction at Albany, treating of any farm subjects desired. You will in this way become familiar with many books of value. They will help you in your Reading-Course work; and when you come to take up your more advanced work in correspondence, you will know just where to lay your hands on the best books.

The Reading-Course for Farmers is now, in this month of November, to be taken up for the winter by nearly eight thousand farmers. Hundreds of young farmers throughout this state will have received this

letter. Nearly fifty Farmers' Reading-Course Clubs are already in practical operation and requests for more are coming in. Now each one of us can help the other. Let us all stand shoulder to shoulder in the great work of studying our surroundings and ourselves. Remember, this Bureau is for your use. It costs you absolutely nothing to take up this work except the postage on the letters that you write to us. For the mailing of Bulletins to you there is no charge. You need not enclose any stamps for that purpose. Write freely to us this winter on anything pertaining to this work of the Reading-Course for Farmers.

Believe me, that in this Bureau is a farmer who knows and feels the burden and the joy of our common work. He is looking to other farmers, especially to young farmers, for comradeship and encouragement. Help him that he may help you. A letter from you at once will be proof of your good faith and interest.

EXTENSION WORK IN AGRICULTURE.

The State of New York appropriates funds for extension work in agriculture, to be prosecuted by the College of Agriculture. This extension work is of many kinds. Most of it may be classified under the following heads:

1. Winter-Courses at Ithaca. These open the 6th of December and continue twelve weeks. There are five of these courses;
   - (a) General Agriculture.
   - (b) Dairy Industry.
   - (c) Poultry Husbandry.
   - (d) Horticulture.
   - (e) Home Economics.
2. Reading-Courses, conducted by correspondence. These are two:
   - (a) Farmers' Reading-Course.
   - (b) Farmers' Wives Reading-Course.
3. Nature-Study work, conducted by correspondence with the school children and the school teachers of the state.
   - (a) Junior naturalist work, for which is published the "Junior Naturalist Monthly."
   - (b) Junior gardener work.
   - (c) Correspondence work for teachers, for whom is published the "Home Nature Study Course."
4. Demonstration and cooperative experiment work on farms. This work is done under the supervision of specialists in the various subjects. Some of the results are published in bulletins of the experiment station.

The other work of the College of Agriculture of Cornell University falls into the following divisions:

1. Teaching.
   (a) Four years' course.
   (b) Four years' course leading to landscape gardening and outdoor art.
   (c) Two-year special course.
   (d) Two-year special nature-study course for teachers.
2. Investigation (experiment station).

Correspondence with any of these activities is invited. Address,

NEW YORK STATE COLLEGE OF AGRICULTURE,
Cornell University,
Ithaca, N. Y.

The Following Bulletins are Available for Distribution to Those Residents of New York State Who May Desire Them.

72 The Cultivation of Orchards, 22 pp.
121 Suggestions for Planting Shrubbery.
126 The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
134 Strawberries Under Glass. 10 pp,
135 Forage Crops, 28 pp.
136 Chrysanthemums, 24 pp.
137 Agricultural Extension Work, Sketch of Its Origin and Progress, 11 pp.
139 Third Report upon Japanese Plums, 16 pp.
140 Second Report upon Potato Culture, 24 pp.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling-Moth.
143 Sugar Beet Investigations, 88 pp.
144 Suggestions on Spraying and on the San José Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work, 26 pp.
147 Fourth Report upon Chrysanthemums, 36 pp.
148 Quince Curculio, 26 pp.
149 Some Spraying Mixtures.
150 Tuberculosis in Cattle and Its Control.
151 Gravity or Dilution Separators.
152 Studies in Milk Secretion.
153 Impressions of Fruit-Growing Industries.
154 Table for Computing Rations for Farm Animals.
155 Second Report on the San José Scale.
157 Grape-vine Flea-beetle.
158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
159 An Effort to Help the Farmer.
162 The Period of Gestation in Cows.
163 Three Important Fungous Diseases of the Sugar Beet.
164 Peach Leaf-Curl.
165 Ropiness in Milk and Cream.
166 Sugar Beet Investigations for 1898.
168 Studies and Illustrations of Mushrooms; II.
169 Studies in Milk Secretion.
170 Tent Caterpillars.
171 Concerning Patents on Gravity or Dilution Separators.
172 The Cherry Fruit-Fly; A New Cherry Pest.
173 The Relation of Food to Milk Fat.
176 The Peach-Tree Borer.
178 The Invasion of the Udder by Bacteria.
179 Field Experiments with Fertilizers.
180 The Prevention of Peach Leaf-Curl.
182 Sugar Beet Investigations for 1899.
183 Sugar Beet Pulp as a Food for Cows.
184 The Grape Root-Worm; New Grape Pest in New York.
185 The Common European Praying Mantis; A New Beneficial Insect in America.
186 The Sterile Fungus Rhizoctonia.
187 The Palmer Worm.
188 Spray Calendar.
189 Oswego Strawberries.
190 Three Unusual Strawberry Pests and a Green-house Pest.
192 Further Experiments Against the Peach-Tree Borer.
193 Shade Trees and Timber Destroying Fungi.
194 The Hessian Fly. Its Ravages in New York in 1901.
195 Further Observations upon the Ropiness in Milk and Cream.
196 Fourth Report on Potato Culture.
198 Orchard Cover Crops.
199 Separator Skimmed Milk as Food for Pigs.
200 Muskmelons.
201 Buying and Using Commercial Fertilizers.
206 Sixth Report of Extension Work.
207 Pink Rot an Attendant of Apple Scab.
208 The Grape Root-Worm.
209 Distinctive Characteristics of the Species of the Genus Lecanium.
210 Commerical Bean Growing in New York.
211 Coöperative Poultry Experiments. The Yearly Record of Three Flocks.
212 Cost of Producing Eggs. Second Report.
216 Spraying for Wild Mustard and the Dust Spray.
219 Diseases of Ginseng.
220 Skimmed Milk for Pigs.
221 Alfalfa in New York.
222 Attempt to Increase the Fat in Milk by Means of Liberal Feeding.
225 Bovine Tuberculosis.
227 Cultivation of Mushrooms by Amateurs.
228 Potato Growing in New York.
230 Quality in Potatoes.
231 Forcing of Strawberries, Tomatoes, Cucumbers and Melons.
232 Influence of Fertilizers upon the Yield of Timothy Hay.
233 Two New Shade-Tree Pests.
234 The Bronze Birch Borer.
235 Coöperation Spraying Experiments.
236 The Blight Canker of Apple-Trees.
237 Alfalfa—A Report of Progress.

Address, NEW YORK STATE COLLEGE OF AGRICULTURE,
ITHACA, N. Y.

SUPPLEMENT TO

CORNELL

Reading-Course for Farmers

PUBLISHED MONTHLY BY THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS JULY 16, 1894
L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING. | ITHACA, N. Y. NOVEMBER, 1906. | No. 31. CLUBS AND CORRESPONDENCE.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 31.

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) *We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons.* (2) *We should like you to use this paper on which to ask questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.*

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT TO THE RECEIPT OF THE BULLETIN. *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this discussion-paper then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public. As the Discussion-paper will contain written matter, it will require letter postage.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. *The Farmers Wives Reading-Course, on domestic subjects, is also sent to those who desire it.*

THESE BULLETINS CAN NOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

This Bulletin calls our attention to the necessity of beginning our reading and study of agriculture at once. It attempts to point out the wisdom of organizing Farmers' Reading-Clubs and of perfecting those clubs already organized. It suggests that the Grange offers an effective starting point for such organizations. It insists that the young farmer is a vital part of the permanent success of the Club. Then, organize now. Below is a Roster to be filled out and returned so that we may correspond with the right parties.

If you are unable to organize a club, then in order that we may know who are interested readers, write out and send to us your opinion of the points suggested. For instance:

Do the most successful farmers in your neighborhood read the Bulletins?

Do the young farmers take an interest in the agricultural affairs of the place? If not, then why?

Will you kindly send us the names of those young men who might be interested but who are not regular readers?

Names of Club..

Date of Organization....................Office Number..........

President ....Address.....................

Secretary ....Address.....................

MEMBERS.	ADDRESS.	SUBJECT.

Name.....................................

Date.....................................

County........................ Postoffice........................

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please write us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

CORNELL

Reading-Course for Farmers

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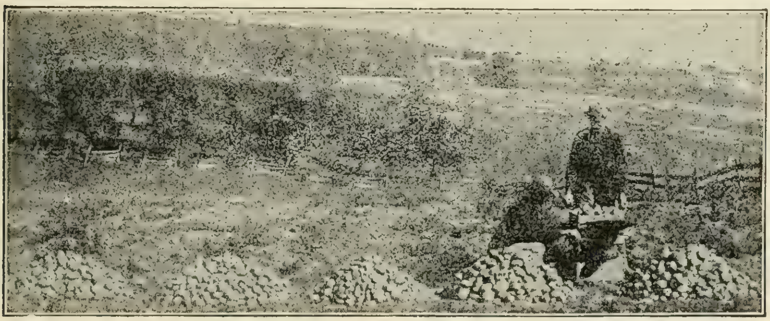
SERIES VII. HELPS FOR READING. | ITHACA, N. Y., DECEMBER, 1906. | NO. 32. FERTILIZERS AND FERTILITY.

FERTILIZERS AND FERTILITY.

[*A Supplement to Bulletin* 3.]

Series VII of the Reading-Course for Farmers does not attempt a new and consecutive study of any one subject. Its purpose is to supplement the former series, making suggestions as to clubs and ways of procedure, and giving additional information on any of the former



Potash Nitrogen. | Potash Phos. Acid. | Nitrogen Phos. Acid. | Nitrogen Phos. Acid, Potash. | Stable Manure.

FIG. 342.—*Experimental plats with different combinations of fertilizing materials.*

Mr. H. H. Jones harvesting and weighing the experimental plats of potatoes.

bulletins as occasion may require. The consecutive Reading-Course bulletins are comprised in the six series heretofore issued. Bulletin No. 3, Series I, of the Farmers' Course, suggests many questions to our readers. These questions have been put to the author of the bulletin, and he has prepared the following statement covering the main points on which information seems most to be wanted; and this statement is published in this form to save correspondence.

FERTILIZER QUESTIONS.

By G. W. CAVANAUGH.

Shall we buy commercial fertilizers, and, if so, what kind?

There are some successful farmers who do not employ commercial fertilizers of any kind, while many others say that they find much benefit in their use. We sometimes hear that fertilizers tend only to stimulate the soil, and to leave it poorer and more exhausted; while, on the other hand, it is said that their moderate use helps to maintain the fertility of many soils. In view of the conflicting opinions as to the advisability of their use, and the still greater confusion as to the choice of the proper kinds, it would seem that we might with profit inquire into a few of the fundamental principles that underlie their composition and their action in the soil.

Why are fertilizers or manures applied to soils?

Probably the original idea of applying manurial substances to the soil was to furnish material that the roots could absorb into the circulation of the plant and there serve as food. Of the many substances used as manures, but few are directly taken up and used in the forms in which they are applied. A few of the constituents of commercial fertilizers are in the proper form to be used directly, while practically all of the constituents of animal manures must first undergo changes before they are available as plant foods. These changes in manures are brought about by different agencies in the soil, some being bacterial and some chemical. The products that are formed in the soil from the decay of stable manure are often identical with those that are applied in the commercial fertilizer. So it is possible to apply fertilizers in one case and manure in another, but have the same kind of materials furnished to the plants in either case. Usually the materials in the fertilizers are more nearly ready to be used by plants than those in manures. Further, the fertilizers are concentrated and compact, while the manures are bulky and contain much less plant-food. To balance this deficiency in amounts of plant-food, manures have some valuable properties not found in fertilizers. But from the point of view of furnishing plant-food, it is not a question of what each supplies, but of the cost, convenience and the form of the materials.

What do commercial fertilizers contain?

The materials used in making commercial fertilizers can be divided into three groups: (1) those containing some form of nitrogen; (2)

those containing phosphoric acid; (3) those containing potash. Following are some of the materials most often used:

Group I, containing nitrogen:

Nitrate of soda contains 15 per cent nitrogen—all directly available.

Dried blood..........	10–12 per cent	Must undergo decay in the soil to liberate the nitrogen in available form.
Tankage	4–10 per cent	
Fish scrap	7– 8 per cent	

Group II, phosphoric acid:

Acid phosphate consisting of phosphate rock or dissolved rock, bones treated with sulphuric acid. The product is the same whether bones or rock are used, and contains 14–16 per cent available phosphoric acid, and about 50 per cent gypsum, or land plaster.

Group III, potash:

Muriate of potash contains 50 per cent potash	All available.
Kainit contains 12-15 per cent potash	
Sulfate of potash contains 50 per cent potash	

The substances named in Groups II and III are the principal ones used to furnish phosphoric acid and potash in all grades of commercial fertilizers. Those in Group I furnish nitrogen in a form that is either directly available or may easily become so, and can be considered high grade materials. It is in the nature of the materials used to furnish nitrogen that one difference is found between high-grade and low-grade fertilizers. Such products as tankage (low in nitrogen), ground-leather scrap and hoof and horn meal, all contain nitrogen, but in such a form that it undergoes the necessary changes in the soil very slowly. In general, the value of a material furnishing nitrogen may be judged (1) according to the readiness with which it decays in the soil, and (2) as to its content of nitrogen. One product may contain 3 per cent nitrogen, decaying easily and be of more actual immediate value than another containing 7 per cent nitrogen resisting decay. Of all substances used to supply nitrogen, the *nitrates,* (as for example, nitrate of soda, or nitrate of potash) are the only ones that supply nitrogen in a form immediately available to plants. All other substances must undergo decay or some change in the soil in order to liberate the nitrogen they contain. As the nitrogen is liberated, it is changed into nitrates by the bacteria in the soil.

The nitrogen that is used by plants must be in the form of nitrates before it becomes assimilated by them. The more easily a material decays, the quicker will its nitrogen become available.

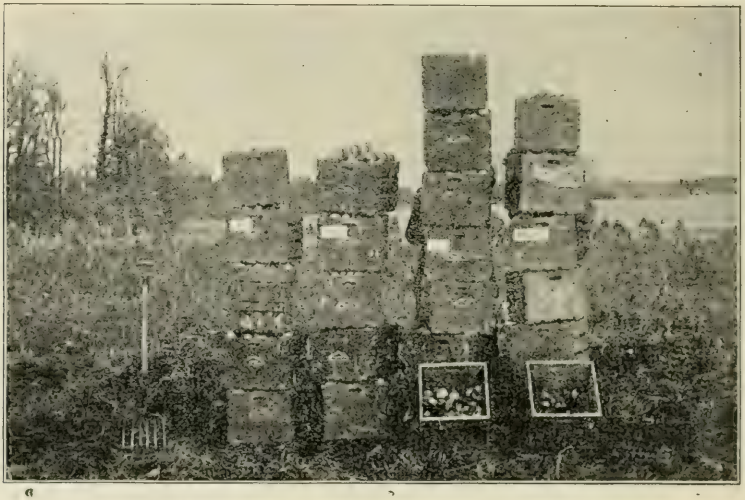
Shall we mix our own fertilizers?

In preparing a complete fertilizer, the maker mixes some of the above materials in such a way that the resulting mixture may contain the nitrogen, phosphoric acid and potash in the desired proportion.

For example: suppose it is desired to have a mixed fertilizer to contain 2 per cent. nitrogen, 8 per cent. phosphoric acid and 4 per cent. potash, and the amount desired is one ton of 2,000 pounds. The ton will therefore have 40 pounds nitrogen, 160 pounds phosphoric acid and 80 pounds potash, because

2 per cent. of 2,000 pounds = 40 pounds
8 per cent. of 2,000 pounds = 160 pounds
4 per cent. of 2,000 pounds = 80 pounds.

The next step is to learn how many pounds of some substance containing nitrogen, will furnish the 40 pounds of nitrogen. If dried blood



Nitrogen. Potash. Phos. Acid. No fertilizer.

FIG. 343—*Potatoes harvested from four of the experimental plats of Mr. M. C. Hatch.*

is to furnish the nitrogen, and the dried blood should contain 12 per cent. of nitrogen (that is, each 100 pounds of dried blood has 12 pounds of nitrogen), then by calculation it is seen that 333 pounds are needed. This is best shown by the old "rule of three," or the rule of proportion:

One hundred pounds dried blood equal 12 pounds nitrogen. How many pounds dried blood equal 40 pounds nitrogen?

$$100 : 12 : : x : 40 \quad \frac{40 \times 100}{12} = 333$$

Or there will be as many hundred pounds of dried blood needed as 12 is contained in 40:

$40 \div 12 = 3\frac{1}{3}$

$3\frac{1}{3} \times 100 = 333.$

In a similar way the amount of acid phosphate is found that will yield 160 pounds of phosphoric acid.

One hundred pounds acid phosphate equal 14 pounds phosphoric acid.

$$100 : 14 :: x : 160 \quad \frac{160 \times 100}{14} = 1{,}143 \text{ pounds.}$$

If muriate of potash supplies the potash, then the amount necessary to yield 80 pounds potash is found in exactly the same way:

One hundred pounds muriate of potash equal 50 pounds potash.

$$100 : 50 :: x : 80 \quad \frac{100 \times 80}{50} = 160 \text{ pounds.}$$

Hence, if one mixes

333	pounds dried blood
1,143	pounds acid phosphate
160	pounds muriate of potash
1,636	total,

there is used enough of each to yield a ton of fertilizer that will contain 2 per cent. nitrogen, 8 per cent. phosphoric acid and 4 per cent. potash. But immediately it is seen that the amounts used do not make a ton of 2,000 pounds. The total weight lacks 364 pounds of being a ton. (2,000—1,636=364.)

This difference is supplied by mixing in some material as a filler; often it has no fertilizing value; sometimes substances are used that have an indirect value, as land plaster. The lower the percentages of the different fertilizing constituents in a fertilizer, the greater is the amount of the filler used.

When these different materials are mixed, they do not act on each other in any way, nor is there any special technical knowledge needed in order to mix them. After learning the amounts of each it may be desired to be mixed, the remainder of the operation is nearly as easy as mixing corn and oats. It sometimes happens that some of the materials get damp and lump up or even cake into more or less solid masses, and to pulverize them may take a little time; but, aside from mechanical

difficulties of mixing, there are no others to be met in preparing a mixed fertilizer from the chemicals.

Whether it is desirable to mix the chemicals at home or to purchase them already mixed, depends largely on whether one cares to expend money or labor. The fertilizer mixed at home has these advantages; it costs less, because one does not pay for the filler, nor freight on it; the filler may be supplied by using dry soil; almost any desired proportion may be obtained; one can be sure of the quality of goods used (this is most important especially of the nitrogen). The charge for

Potash. | Potash. Phos. Acid. | Potash Nitrogen. | Nitrogen Phos. Acid, Potash. | No fertilizer.

FIG. 344.—*Mr. A. O. Stewart harvesting corn fodder for the silo. Each shock represents the yield from one sq. rod of each plat.*

mixing is also saved. It may have the disadvantage of not being so well mixed, as the manufacturers usually have machines adapted for thorough mixing. That mixed by machinery may be easier to use in drills because of greater fineness and uniformity.

When small quantities are bought the saving may not be great; but users of large amounts may well afford to do some home mixing. When a sufficient amount is to be used by several in a neighborhood, the home mixing may often be profitable.

What About the Leaching of Fertilizers?

All nitrates, as nitrate of soda, dissolve very readily in water, and hence may be partly removed from the soil by leaching.

The blood, tankage, etc., are not lost by leaching, but remain in the soil and gradually undergo decay.

While the phosphoric acid of dissolved rock is soluble in water, it cannot be leached out of a soil. As soon as the phosphoric acid comes in contact with the soil, it becomes "fixed" in a form that entirely resists loss by leaching even with heavy rains.

In many soils the potash is also "fixed," though in a few there may be some loss. It is more difficult to tell how the potash will be affected. It depends on the constitution of the particular soil, and the chemical changes that take place therein.

How do Fertilizers compare with Manures?

The commercial fertilizers supply practically no humus or humus-forming materials. Even if they were one-half humus, the amount supplied in any ordinary application would be insignificant. The natural humus of the soil gradually tends to diminish in amount through decay. Humus, more than any other constituent, gives to soils their water-holding capacity. Hence, it follows, that the continued use of fertilizers, without the use of humus, will eventually bring the soil to a condition in which it will have less water-holding power and less ability to resist drought, though it may be richer in added plant-food constituents. On the other hand, the best results from fertilizers are obtained on soils well supplied with humus, which helps to hold the water to dissolve them for the roots.

Manures are nearly all matter that will form humus and contain relatively small amounts of plant-food constituents. This humus-forming material readily decays. As the humus decays, it yields some carbonic acid to the soil-water. This carbonic acid increases the power of the soil-water to dissolve the necessary plant-food constituents in the soil. There seem also to be other products resulting from the decay of humus that make plant-foods available that, without the presence of humus, are not so easily rendered of value. It is in the humus that the soil supply of nitrogen is stored. This humus nitrogen is made available by the same process that renders the nitrogen of dried-blood and tankage available.

We have in the case of manures, then, substances high in humus-forming materials which directly supply nitrogen and through their decay in the soil, indirectly, furnish available phosphoric acid and potash from the mineral part of the soil. All manures supply some phosphoric and potash which become available, when the manure decays.

Fertilizers supply practically the same elements of plant-food that are furnished by decaying humus, but, in a form, that can be more quickly used by the plants. They furnish no humus, and their continued use without stable manures or some form of green manuring, leads to

a decrease of the humus. There is no difference between the kinds of plant-foods required by corn and those required by potatoes. All plants use the same substances, though the proportion of the different kinds may sometimes vary.

How can we know what fertilizers to apply?

The utility of the different kinds of fertilizer constituents is determined as much by the kind of soil on which they are to be used, as by the kind of crop to be grown.

A soil rich in humus, as a muck-soil, has no need of more nitrogen. It usually has enough, often too much for the amounts of phosphoric acid and potash that it contains.

Probably the best substances to render the nitrogen of muck available are wood-ashes and lime.

A light sand or sandy loam, when the humus has been partly exhausted, usually stands in need of nitrogen.

Specific rules cannot always be given for the choice of fertilizing elements. Only in a general way, some suggestions, as the following may be given:

1. Soils poor in humus need nitrogen. Fertilizers give a temporary supply. A more permanent supply comes only with a renewed increase in the humus supply of the soil. This increase is to be found in the incorporation of manures, the turning under of green crops, and in the decay of roots.

   Crops that show short growth and fail to develop abundant foliage, may be in need of nitrogen. Sometimes the soil lacks the necessary amount, and sometimes it is present, but not becoming available through decay of the humus. In the latter case, the cause may be need of drainage, lack of lime, or insufficient tillage.
2. Phosphoric acid is used abundantly by the cereals and, in general, by crops that mature their seeds. It frequently is deficient in sandy soils, where it may be preceded or followed by an application of lime. No form of lime, except plaster, should ever be mixed with fertilizers that contain phosphoric acid, before they are used.
3. Potash is used most abundantly by plants that develop starch and sugar, as potatoes and beets. Most New York state soils, except light sand, contain more potash than phosphoric acid and as a rule are more benefited by the application of phosphoric acid than potash. Moreover, every one hundred pounds of dissolved rock contain about fifty pounds of last plaster, which, on many soils, has a tendency to unlock the potash and make it available.

The following general plan would seem worth working toward: secure the greatest amount of nitrogen through manures, feeds and leguminous crops and, thereby, save the cost of the most expensive constituent in fertilizers. Nitrogen costs from fifteen to twenty cents per pound.

In an experimental way, try the purchase of phosphoric acid alone in the form of dissolved rock. The ordinary stable manure is more deficient in phosphoric acid than in other constituents. The plaster of the dissolved rock, and the decaying humus from the manures, in many cases will furnish sufficient potash from the soil.

Chemical analysis may or may not afford a guide to the fertilizer needs of the soil. Most often it does not furnish a reliable guide, although it may at the same time give useful hints and suggest what further lines of study may be pursued. This subject is discussed in Bulletin No. 3, to which these notes are intended to form an appendix. Chemical analysis is only one of the means of determining soil fertility questions. Careful tests by means of crops, under conditions of control, usually give safer farm-practice results than mere chemical analysis.

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L. H. BAILEY, DIRECTOR.

SERIES VII. | ITHACA, N. Y., | No. 32.
HELPS FOR READING. | DECEMBER, 1906. | FERTILIZERS AND FERTILITY.

SUPPLEMENTAL DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 3.

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT TO THE RECEIPT OF THE BULLETIN. *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this discussion-paper then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public. As the Discussion-paper will contain written matter, it will require letter postage.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. *The Farmers' Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.*

THESE BULLETINS CAN NOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

The purpose of this BULLETIN is to point out a few of the ways by which commercial fertilizers and farm manures furnish plant-food constituents. One class is concentrated and quick acting; the other less compact and brings results by indirect action.

A discussion of the following questions will help you to get at the underlying principles.

1. When a soil is "worn out," what material has most probably been diminished?

2. When a soil produces oats with short straw, what element of fertility is most often lacking?

3. What kind of soil has plenty of nitrogen? What kind has plenty of potash?

4. What sources of nitrogen in fertilizers should be used if one wishes part of the nitrogen to be quick acting and part to become available as the season advances?

5. When grain grows with long straw and lodges, what fertilizing element is abundant in the soil and what elements should be added if any?

6. What amounts of nitrate of soda (15 per cent. nitrogen), dried-blood (10 per cent. nitrogen), acid phosphate (14 per cent. phosphoric acid), and sulphate of potash (50 per cent. potash), would be required to make a ton of fertilizer with the following composition; nitrogen 2 per cent. (one-half to come from the dried-blood and one-half from the nitrate of soda), phosphoric acid 7 per cent. and potash 6 per cent?

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CORNELL
Reading-Course for Farmers

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L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING. | ITHACA, N. Y., JANUARY, 1907. | No. 33. POULTRY HOUSE CONSTRUCTION.

QUESTIONS ON POULTRY HOUSE CONSTRUCTION.

[*A Supplement to Bulletin 16.*]

By JAMES E. RICE and R. C. LAWRY.

Since the Reading-Course Lesson number 16 of the Poultry Series was issued, many questions have been asked about the building of poultry houses. Many requests have been received also for plans of a poultry house which we could recommend for the State of New York. Information regarding the value of trap nests and how to make them has frequently been sought. This Supplement to Bulletin 16 is intended to answer some of the most important questions which have been asked by readers to furnish working plans, estimates of materials required and

FIG. 345.—*The completed house.*

cost of a house for laying purposes and for a trap nest. We cannot give the necessary information in letters.

Q. 1. *What is the best location for a poultry house?*

Ans. 1. Page 278, paragraph 1. *Figure 346 shows the natural slope of the land selected for building the house, which provides for perfect water drainage without the use of tile. The location is naturally dry and sheltered. The illustration shows the natural shelter for the house, provided by trees and buildings in the background. This insures the building being several degrees warmer than it otherwise would be because the shelter breaks the force of the prevailing wind. It faces the south, which gives the greatest benefit from the sun's rays.

Q. 2. *How large a house is it best to build?*

Ans. 2. Page 279, paragraph 1. Where long houses are used it will be necessary to provide double yards or to remove the fowls from the single yards during the early fall while the land is being fitted and reseeded. The same objection applies to the colony house system unless the houses are removed each year to new ground. The house described is twelve feet wide and twenty-four feet long, divided into two pens, each twelve feet square. The nearer square each pen can be built, the less will be the cost for building material. On a large commercial poultry plant it would be economy to build the house at least fifteen feet wide, making the pens fifteen feet square. The house here described is used for instructing students in the care of fowls, where it is necessary to keep smaller flocks in order to accommodate a large number of students. This house is but two sections of a long continuous house to be built which will contain thirty pens, making a house three hundred and sixty feet long with an overhead trolley through the center of the house. By making the house continuous rather than making separate colony houses, the cost is greatly reduced because it is less expensive to build the partitions that divide the pens than it is to build the end of each house where the houses are separate. The colony houses are also much colder because they are more exposed.

Q. 3. *How high should a hen house be built?*

Ans. 3. Page 280, paragraph 1. The house is four feet eleven inches in the rear and eight feet seven inches in front, which is as low

*The references apply to the page and paragraph of the Reading-Course Bulletin Number 16 on Building Poultry Houses, in which the principles are discussed. It is hoped that the readers will refer to each of the references for a more detailed statement as to the reasons why the poultry house described in this Supplement is recommended.

as it is possible to build without danger of bumping the head while doing the work. (Figs. 345, 346, 347, 348 and 351.) On a house fifteen feet wide the front and back could remain the same height as in the house twelve feet square, the pitch of the roof simply being a little less steep. The purpose in view has been to make the roof as low as possible to restrict the air space. A common fault in many hen houses is that they contain too much air space to be warmed up by the bodies of the hens. If the same rule should be followed in building hen houses as is recommended for the building of cow stables *i. e.,* one

FIG. 346.—*Students making the foundation.*

cubic foot of air space for each pound of live weight and if hens are allowed five square feet of floor space per hen with hens weighing five pounds each the house would be but one foot high. It will be readily seen that if a house is built as low as it is possible to build it and enable one to do the work conveniently, it will still contain more than five times as many cubic feet of air space per pound of live weight as is provided in the average cow stable.

Q. 4. *Which is the best style of roof to build?*

Ans. 4. Page 280, paragraph 3. A shed roof is used because it is easiest to build, provides the largest volume of sunlight and therefore provides the best possible conditions of sanitation, warmth, brightness,

and dryness, but requires a trifle more building material than is necessary to build a house of the same size with a "combination roof," or a "gable roof." Observe in Figures 348 and 351 the absence of projection on the north side. This construction enables the paper to be run continuously without break at the eaves, thus making an air-tight joint and preventing rain water from washing the soil and doing away with eave troughs.

Q. 5. *How many square feet of floor space should be allowed per hen?*

Ans. 5. Page 282, paragraph 1. Each pen is intended to accommodate from thirty to forty fowls each, which allows from four to five

FIG. 347.—*Putting up the frame work.*

square feet of floor space per hen. Where fowls are more crowded than this, they get the benefit of greater warmth because they heat up the air space more effectively, but suffer because they have less freedom of action and, where proper ventilation is not provided, are likely to suffer the ill effects of a contaminated, stagnant air. The more fowls that are kept in a given space, the more often the pens must be cleaned. The smaller and more active breeds appear to require a little less floor space per hen than do the larger fowls, even though the heavier fowls are less active, and theoretically would require less freedom of action.

Q. 6. *How many hens should be kept in one flock?*

Ans. 6. Page 282, paragraph 3. It seems to be pretty well established that where flocks are given the same number of square feet of floor space per hen, the smaller flocks' will give the largest maximum yield of eggs. This is because each hen has more independence of action and feels more contented. She is usually given more individual attention by the attendant, also. Small flocks, however, require too much labor. Therefore, the tendency of the time on large commercial plants is to keep fowls in larger and larger flocks. The large flocks seem to result in the largest net profit. Just how large flocks can be

FIG. 348.—*A more advanced stage.*

kept to the best advantage is yet to be determined. From fifty to sixty seems to be the best sized flock, all things considered. Nevertheless, men are succeeding well with flocks of from one to two hundred. With these very large flocks, especial care must be taken to carefully grade the flocks according to size and vigor and greater care must be exercised in regular and liberal feeding, in order that the weaker shall not suffer in a struggle with the stronger individuals. There is always an advantage that comes to each fowl in a large flock which does not come to the fowls in smaller flocks provided all have the same number of square feet of floor space, which is that in large flocks, each hen has a larger actual floor space in which to live giving her more freedom.

Q. 7. *What is the best foundation for a hen house?*

Ans. 7. Page 282, paragraph 2. It will be observed that the foundation is built of concrete which is less expensive than stone, more effective in keeping out water, less liable to heave and less likely to be penetrated by rats and more easily made than is a stone foundation which is laid in mortar and pointed up. (Figs. 346 and 347.) For a hen house, the wall need not be more than eight to ten inches thick. It should stand at least six inches above the natural level of the land and need not go more than six or eight inches below the surface. To make a grout wall, stakes should be driven where each corner of the building is to be located. A cord is then strung two feet beyond each post in all directions and stakes driven. Other lines may be strung from stakes eight inches inside the corner posts which mark the width of the wall. The cords may then be temporarily removed and the trench dug enough wider than the actual wall is to be, to permit retaining stakes to be driven and boards nailed on the inside to hold the grout. This wooden frame should be made perfectly level on all sides.

Purchase the best Portland cement. Use only clean, sharp sand. Mix dry one part cement to four parts sand. Add to this five parts fine, clean gravel or fine cracked or small stone. Mix with water many times until every particle of cement has been distributed uniformly through the mass. The secret of good cement work is first in the quality of cement and sand used and second in the thorough mixing. When in a puddling condition it can be scooped into wheelbarrows and thrown into the wooden frame and thoroughly tamped. After the wall has set, which requires only a day or two, the frame work may be removed.

Q. 8. *What is the best floor for a hen house?*

Ans. 8. Page 284, paragraph 1. The floor is made of cement because it is more easily cleaned, more nearly rat proof, more durable and dryer when made properly than is any other floor. A good cement floor should have a well drained foundation. This is most easily provided by filling in with fine stone to within an inch or two of the level of the foundation wall. Over this can be spread the same grout mixture as was used in the foundation, and on top of this should be placed about half an inch of the cement mixture, made one part cement to four parts of sand and troweled to a perfect level. The 2x4 sills should be placed before the cement floor is laid. The cement can then be flushed against the sill to prevent air and water entering between the sill and the foundation. In some cases it may be advisable to make the cement floor level with the top of the sill.

Q. 9. *Is it necessary to have double walls and dead air space in a poultry house in this state?*

Ans. 9. Page 282, paragraph 4. The walls on all sides, except the south, are made of one thickness of matched pine lumber, with the plain side on the inside of the house, in order to improve the appearance and to make it more easily white-washed. The outside, except the south side, is covered with one thickness of " red rope roofing." Half of the roof is covered with " red rope roofing," the other half with " paroid " to determine their relative efficiency. The side, ends and front are painted a light straw color, which is more attractive than the red, which is the color of the paper. It serves the double purpose of attractiveness and durability, both of which count for much in a poultry establishment. The only part of the house that is double-boarded is a portion directly back of and above the roost platform. An air space is formed between the studding and the inner boarding, which is opened above and below. Holes were bored through the plate, which permit the air to circulate freely up between the studding, through the plate between the rafters and out into the room again. This makes the inner wall warmer than it would be with a dead air space, owing to the fact that the air is continually changing, and therefore must be nearer of temperature of the room than it could possibly be with a dead air space, which in time becomes as cold as the outside boarding. For this reason a " dead air space " is objectionable. A cold, dead air space would in turn cool the inner boarding, in which case it would become as cold as the dead air space, thus causing condensation of moisture from the warm air, making the walls wet. This moisture in case of extreme cold would freeze causing the walls to be covered with frost.

The front of the house is made of one thickness of shiplap without paper either inside or out, which is a loose construction. This type of wall more readily warms up the air on the inside when the sun shines than would a double wall, and owing to the fact that all other sides of the house are made tight, this warmed air does not readily pass out because the house is free of draft. The principle of this construction is best expressed by the comparison that " you cannot blow into an open bottle." In a house that is tight on all sides, or with an open bottle, the air will change gradually and surely.

It will be observed that the frame work is made wholly of two by fours, with the exception of the rafters which are two by five. The studding being placed four feet apart and the rafters two feet apart between centers. The boards are laid horizontally.

Most of the front of the house is filled with door and window openings, which is easy of construction, and requires a small amount of material.

Q. 10. *What causes dampness in a hen house?*

Ans. 10. Page 283, paragraph 2. The intent has been to construct a house that first of all should provide fresh, pure air; second, that would insure reasonable dryness; third, that would be as warm as is consistent with fresh air and dryness without the use of artificial heat, or overcrowding the fowls.

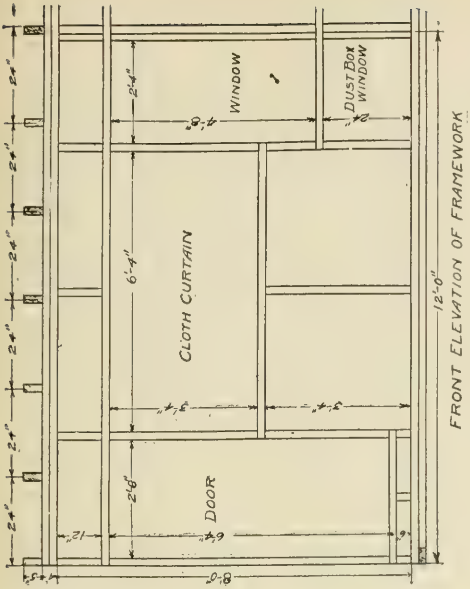
Dampness in a hen house is caused primarily by warm air taking up moisture by evaporation and having the moisture condensed (squeezed out) by becoming cold. Moisture occurs in a hen house from the breath of fowls, from the droopings and the water pans. If the house is open, this air ladened with moisture can pass out readily so that the air within is as dry as the air without. If the air is closely confined in a tight house, condensation takes place inside the house.

If the house were as tight on the front as it is on the other sides, top and ends, and without ventilation, the air would become warmer, thereby absorbing more moisture which when the outside walls become cold would condense the moisture by coming in contact with the cold walls. The moisture when condensed out of the air makes the litter and walls damp, and we say that the house "sweats." Whenever this moisture is again taken into the air, the house is made cold by the process of evaporation. That is one reason why a damp house is a cold house. This principle may be easily tested by observing how much colder a hand becomes that is wet than the one that is dry, the temperature conditions being the same, and how sprinkling the floor of a room during hot weather cools the air.

It will readily be seen, therefore, that houses are damp, first because they are tight which prevents the moist air from passing out, and second that the walls either solid or with a dead air space become cold, which causes the moisture to be "squeezed out" from the air. Dampness then can be prevented by avoiding extremes of temperature and by providing an easy exchange of air.

Q. 11. *What is the best way to ventilate a hen house?*

Ans. 11. Page 287, third paragraph. The most economical and effective method of ventilating the house appears to be by window openings in the south side of the house, which during the larger part of the time, both summer and winter, are covered simply by wire, and which during stormy or excessively cold weather are covered by a cloth window. This, if the house is tight on all other sides, allows for a quiet diffusion of air with the least possible draft. The reason why the modern ventilators, which



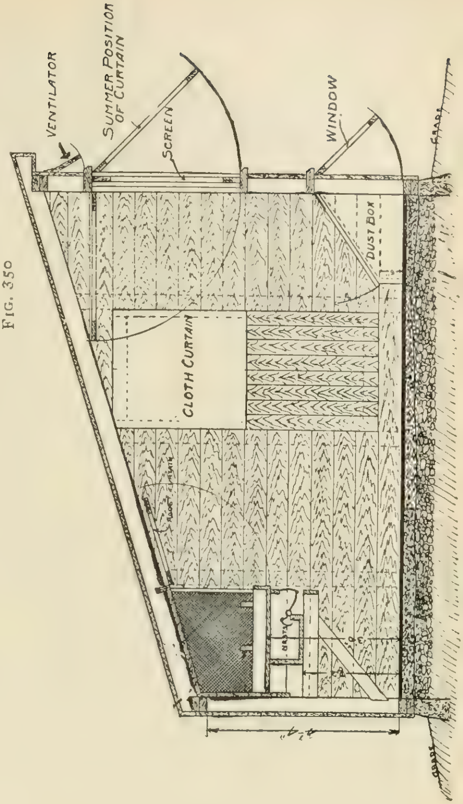


FIG. 350

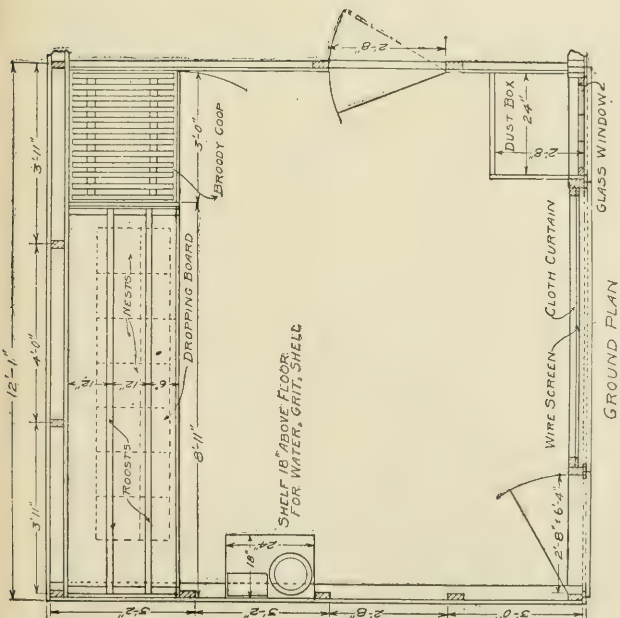


FIG. 349

Fac-simile reproduction of student's drawing of Laying House designed and used by the Department of Poultry Husbandry, New York State College of Agriculture at Cornell University, Ithaca, N. Y.

work quite satisfactorily in dwelling houses and barns, fail to work in a hen house is that there is so small an amount of heat generated by the bodies of the fowls in proportion to the amount of air space; and second from the fact that the house is subject to so many changes through the opening and closing of doors and windows, or the loose construction which sets up counter-currents, causing the system to fail to always "draw" in the right direction. Pure air is even more important for poultry than for other domestic animals. This is because their body temperature is 105–6 degrees, which is several degrees higher than it is with most animals. The body temperature is maintained by combustion of food nutrients with the oxygen of the air. If oxygen is lacking, the body fires smoulder and impure blood results.

Q. 12. *How much window surface should be placed in a house?*

Ans. 12. Page 284, paragraph 2. The modern hen house must provide healthfulness and good cheer by admitting an abundance of sunlight, which shall have direct access to every part of the house. This is obtained most effectively by placing the top of the window high and the bottom low. This makes a comparatively long, narrow window, and provides for a wide sweep of sunlight as the sun passes from east to west. By placing the windows near together, and making that part of the partition next the front of the house of wire, the sunlight can pass through so that each pen gets the benefit of the sunlight from its own window and that of the other pen also. (For experimental purposes the partition as shown is of wood.)

The windows are hung on the side and swing against the partition in which position they are readily opened and closed. When opened, as they should be during the entire summer season, they are in the most secure place possible to avoid breakage.

This house is provided with 31 square feet of glass surface which is .51 square feet per fowl.

The glass windows are two feet four inches by two feet eight inches, and contain eight by ten inch glass.

Q. 13. *Would you advise the use of cloth windows?*

Ans. 13. Page 288, paragraph 2. Each pen of the house is provided with a cloth frame hung at the top, covering a window opening six feet four inches by three feet four inches. (See Figs. 345, 349, 350.) The two cloth windows furnish 84.3 square feet of cloth surface, which is nearly one square foot per fowl, about two and one-half times as much cloth surface as glass area. The top of the window is six feet eight inches from the floor, the bottom three feet four inches from the floor.

Q. 14. *What is the best way to make a house cool in summer?*

Ans. 14. It is as important that the house be kept cool in summer as it is that it shall be warm in winter. It is a common fault in hen house construction to overlook the importance of providing for the free circulation of air, particularly the escaping of warm air, which accumulates in the higher parts of the house. In order to overcome this defect in a measure, an opening is provided above the windows where a door hung at the top swings out, shading the opening so that the sun cannot shine in, and permitting the warm air which accumulates at the highest portion of the roof to pass out freely. (See Figs. 345, 349, 350, 351.) This is intended primarily for hot weather use but can be used to advantage at other times. The cloth window is hung so as to be swung outward thus forming an awning during the hot weather.

Q. 15. *Is it necessary to provide a dust-bath? If so, why?*

Ans. 15. Page 290, paragraph 4. A dust-bath is a necessary evil. It is necessary to provide the hens with their most natural and most effective means of destroying lice. It is an evil because necessarily the dust that is kicked up must be breathed by all of the fowls in the house. This dust also causes the house to be dirty.

An attempt has been made in the house described to construct an inexpensive, warm, dry, sunny dust-wallow that will leave the least possible dust in the house. It is provided by constructing a well six or eight inches deep in the floor of the house directly under the glass window. This was planned for when the floor was made. A two-light cellar sash two feet four inches, by two feet is placed directly under the glass window, and is hung at the top so as to swing outward. A wire screen covers the opening on the inside. The dust-wallow can be emptied or filled readily from the outside. An incline on the inside from the window sill to the floor covers the dust-wallow. The hens enter from a narrow opening at the end. This arrangement furnishes a splendid dust-wallow, with very little dust escaping into the room except when fowls come out to shake themselves, which they frequently do. It is a decided improvement over the dust box ordinarily provided. Use sifted coal ashes with a little land plaster for the dusting material.

Q. 16. *What is the most satisfactory nesting and roosting arrangement?*

Ans. 16. Page 286, paragraph 3. The entire inner arrangement of the house is portable. The platform, the perches, the nest boxes are all movable without drawing a nail, which facilitates fighting vermin.

The arrangement here described (see Figs. 349, 351) provides for a trap nest for which detailed plans are furnished (see Figs. 352, 353,

354, 355, 356). If trap nests are not desired, the nests will be located in the same place but will have one door hung at the bottom in front of the nests, which are located under the platform, the hens entering from the rear.

Nests are provided in the proportion of one nest to about five fowls. There are about 18 linear feet perch-room in each pen, which is about seven inches perch-room per fowl.

A broody coop is provided in connection with the roosting arrangement where it is most out of the way, and most convenient to place fowls as they are removed from the nests in each pen.

The floor of the broody coop is slatted, which keeps the floor clean and dry. The false floor is easily thrown back to clean the platform. A cloth frame hinged to the rafters can be shut down in front of the roost platform. This will only need to be used during exceptionally cold nights. The roosting room or hooded roost provides about thirty-six square feet floor space, including broody coop, and contains fifty cubic feet of air space, which is allowing one-half cubic foot of air space per pound of live weight of fowl, estimating that thirty fowls are kept in the pen and that they weigh on an average of four pounds each. This would be too small if it were not for the cloth curtain which permits of exchange of air.

Q. 17. *Is it necessary to have a "scratching shed"?*

Ans. 17. Page 288, paragraph 1. It will be observed that this house is all scratching shed. The only roosting pen provided is the hooded roost. This construction requires the least possible outlay for building material, permits the fowls to enjoy a sheltered, protected life in the open air on all days except during blizzard weather without the exposure of open sheds, and thus avoiding on the other hand the close, enervating, sultry conditions of the tight poultry house.

Q. 18. *Is it advisable to have an alleyway?*

Ans. 18. Page 286, paragraph 1. This house is the first two sections of a long continuous house, the remaining sections to be built later. No alleyways are provided. The hens, therefore, get the benefit of the entire floor space. The attendant is compelled to be among the fowls when caring for them, and much expense is saved both in labor and materials in constructing the interior of the house. Nearly one-fourth the expense in house construction is avoided by not having an alleyway.

Q. 19. *Should a poultry house be built to conform to the slope of the land or should the foundation be level?*

Ans. 19. The land slopes gradually to the west, dropping about five feet in two hundred feet. This makes it necessary for the pens which

are to be constructed later to be placed on different grades, the level of the floor of each two pens being lower than the pens on the east. This is the best method of placing poultry houses on sloping land

Where the house is built to conform with the grade of land, the lower pens are colder than the higher pens because the cold air settles. The litter also works to the lower part of the pen leaving the higher portions of the floor bare. The appearance of such a house is very unsatisfactory to the eye. The house appears to be out of joint. The windows, doors and all openings in front must necessarily be placed plumb, and cannot conform to the shape of the house.

Q. 20. *Should doors be placed in the front or on the side only in a long house?*

Ans. 20. Doors are provided in front of each pen, the attendant entering each pen from the walk in front of the house. This is necessary in a house intended for instruction purposes where each student has a pen. The sill of all door openings is six inches above the floor to prevent the litter from being scratched out. On a commercial ranch there would be very little necessity for entering from the front, the work being done through doors near the middle of each partition, the attendant passing from pen to pen through the entire house. Where a trolley is to be used, the double door swinging both ways on reversible hinges is highly desirable. Where trolleys are not used, a single door swinging both ways on double hinges is preferable. A front door opening is convenient but not necessary. Where the window swings on the side it can be used as a door if required to receive and remove litter, and also for passage on occasions where it becomes necessary, which is not often where the attendant passes through from pen to pen.

TRAP NESTS.

A trap nest simple in construction, inexpensive and easy of operation is here described, the plans, dimensions and description of which are here given by which any person desiring to make the nest can do so. (Figs. 352, 353, 354, 355, 356.) It is not patented, and is presented to the public as a contribution from the Department of Poultry Husbandry of the New York State College of Agriculture at Cornell University.*

Trap nests serve an excellent purpose in the hands of colleges and experiment stations for instructional, investigational work. They are of practical application and value only to a limited number of persons who are engaged in commercial poultry keeping. Few poultrymen can afford

*The trap nest device is an invention of R. C. Lawry, Instructor in Poultry Husbandry at Cornell University.

to spend the time necessary to look after the traps the large number of times necessary during the day, to mark fowls and eggs and keep records of the chickens hatched therefrom. To the poultryman who will give attention to this necessary detail with a few of the choicest pullets each year, even for the first few months of production, much can be accomplished in determining approximately the best producers which can be used the second year for breeders.

The main dependence, however, for selecting breeders should first be evidence of constitutional vigor and vitality as shown by rapid growth, healthy plumage, clear eye, heavy shank, and other indications of stamina, together with early laying qualities and general action and appearance up to and including the time they are used for breeding purposes.

BILL OF LUMBER MATERIALS FOR THE LAYING HOUSE.

35 bags Cayuga cement.
12 pieces 2″ x 4″ x 12′.
6 " 2″ x 4″ x 14′.
20 " 2″ x 4″ x 10′.
13 " 2″ x 5″ x 14′.
4 " 2″ x 6″ x 12′, milled like sketch.
2 " 1″ x 4″ x 12′.
2 " 1″ x 6″ x 12′.

All of above stock hemlock and surfaced four sides.

15 ft. 1″ x 12″. Basswood or poplar. No shakes or cracks.
15 ft. 1″ x 6″. " "
30 sq. ft. cove siding in 12 ft. lengths.
50 sq. ft. " " " 14 ft. "
786 sq. ft. sap pine flooring in 14 or 16 ft. lengths, surface one side.
400 sq. ft. sap pine flooring in 12 ft. lengths only, surface both sides.

2 pieces 1⅛″ x 4″ x 12′.
2 " 1⅛″ x 4″ x 14′.
3 " 1⅛″ x 2″ x 16′.
15 " 1⅛″ x 3″ x 12′.
4 " 1⅛″ x 3″ x 10′.
6 " 1⅛″ x 1⅛″ x 12′.
6 " 1⅛″ x 3″ x 14′.
140 lin. ft. ½″ x 1″ window stop.

Above to be good grade white pine surfaced four sides. Cost $91.87.

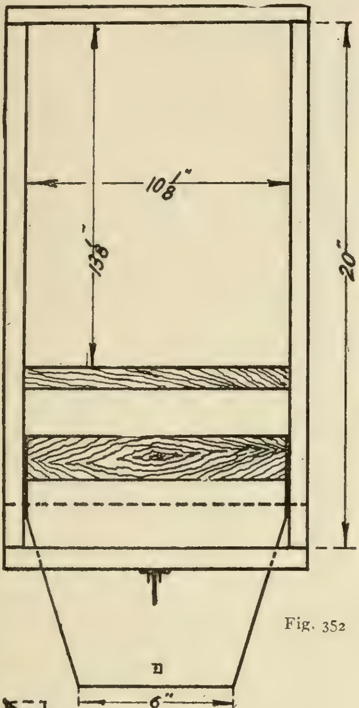


Fig. 352

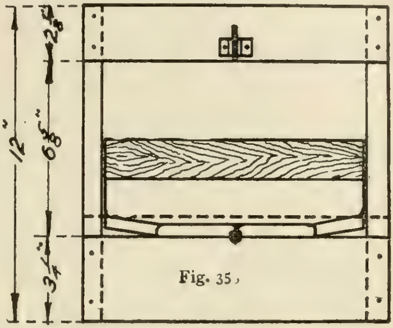


Fig. 353

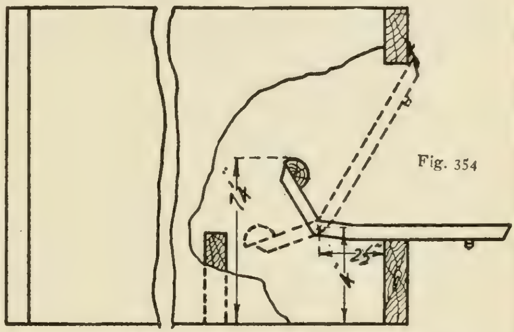


Fig. 354

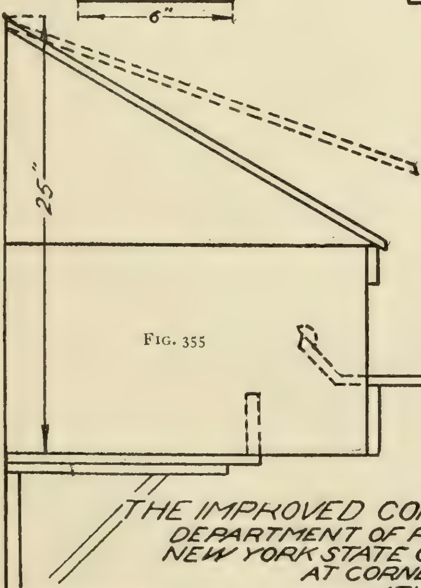


Fig. 355

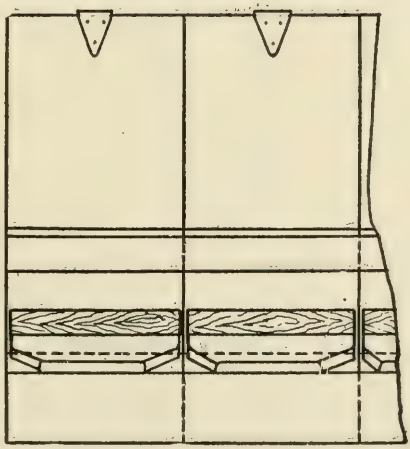


Fig. 356

THE IMPROVED CORNELLIAN TRAP NEST
DEPARTMENT OF POULTRY HUSBANDRY
NEW YORK STATE COLLEGE OF AGRICULTURE
AT CORNELL UNIVERSITY
ITHACA, N.Y.

BILL OF HARDWARE MATERIAL FOR THE LAYING HOUSE.

2—9 light 8″ x 10″ glass.
2—6 " 8″ x 10″ " sash.
2—2 " 12″ x 14″ " (cellar sash.)
3 pair 3″ lt. loose pin butts (present steel.)
11 " 3″ light T hinges. Hinges.
2 " 2½″ light loose pressed steel butts.
2 " 4″ double action spring butts (steel.)
Screws for all of above.

4 rim night locks (2 keys.)
6 1½ japanned iron buttons.
3 lb 5d nails (box.)
10 lb 10d " Locks.
10 lb 8d "
25 lb 20d "
7 ½ Neponset.
2 gal. No. 6 17 paint (DeVoes.)
Cost $24.35,
Total material cost $116,22.

SUPPLEMENT TO

CORNELL

Reading-Course for Farmers

Published Monthly by the New York State College of Agriculture at Cornell University from November to March, and Entered at Ithaca as Second-Class Matter under Act of Congress July 16, 1894
L. H. Bailey, Director.

SERIES VII. HELPS FOR READING.	ITHACA, N. Y., JANUARY, 1907.	No. 33. POULTRY HOUSE CONSTRUCTION.

SUPPLEMENTAL DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 16.

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) *We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons.* (2) *We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.*

The Next Reading-Course Bulletins will be sent to those who return to us this Discussion-paper, which will be an acknowledgment to the receipt of the Bulletin. *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this discussion-paper then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public. As the Discussion-paper will contain written matter, it will require letter postage.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. The Soil and the Plant. 2. Stock Feeding. 3. Orcharding. 4. Poultry. 5. Dairying. 6. Farm Buildings and Yards. *The Farmers' Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.*

THESE BULLETINS CAN NOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

The purpose of this Bulletin is to give a brief description of the essential factors embodied in the construction of a laying house for the State of New York. Do you agree or disagree? The following hints may help you.

1. What points should be considered in choosing a good location for a hen house and how should it be faced?

2. Explain why a hen house becomes damp. Tell what you would do to avoid dampness.

3. Discuss the comparative advantages and disadvantages of the colony house system and the long continuous house system of building a poultry plant.

4. Discuss the comparative advantages and disadvantages of a long, narrow house and a wide, short house of the same hen capacity.

5. Does warm air rise or fall?

6. Does warm air hold more or less moisture than cold air?

7. Does the evaporation of moisture in a poultry house cause the air to be warmer or colder?

8. How does dampness affect the temperature of a house?

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CORNELL

Reading-Course for Farmers

PUBLISHED MONTHLY BY THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS JULY 16, 1894
L. H. BAILEY, DIRECTOR.

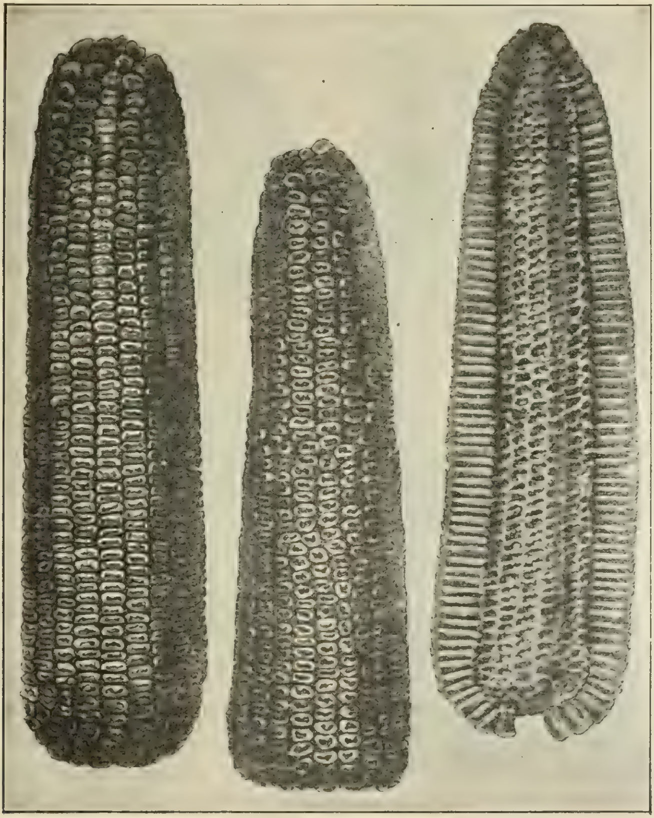
SERIES VII. HELPS FOR READING. | ITHACA, N.Y., FEBRUARY, 1907. | No. 34. CORN AND SILAGE.

SEED-CORN FOR GRAIN AND SILAGE.

[*Supplement to Bulletin 9.*]

BY T. L. LYON.

One of the striking features of recent agricultural progress is the attention that is being given to the improvement of crops through seed

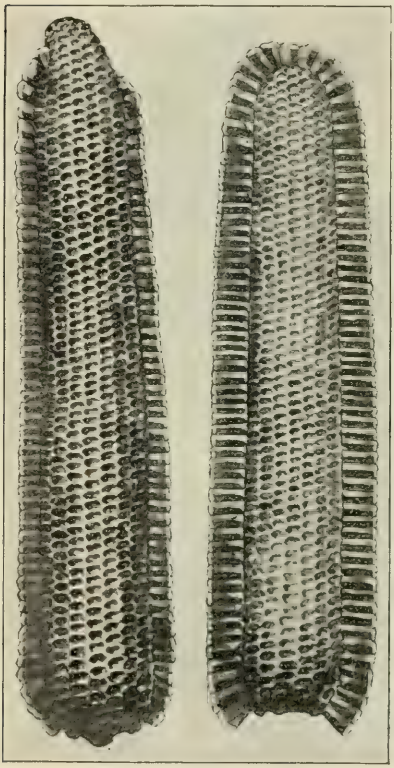


A *B* *C*

FIG. 357.—*A, Cylindrical ear. B, Tapering ear in which several rows of kernels drop out between the butt and tip. C, Tapering ear in which the kernels become shallower towards the tip. From "Examining and Grading Grains."*

selection. In this way the farmer has probably accomplished more with corn than with any other crop. It is in the region in which corn is grown for grain that the improvement has, in large part, been accomplished, but there is no reason why dent corn for ensilage in New York State cannot be improved in the same way. This paper will deal only with dent corn.

In the region of country using silage most abundantly the corn that matures grain successfully in a normal growing season, and that does not have an excessive proportion of stalks has been shown beyond question to be the best corn for silage. It is likewise true that corn raised year after year in one locality yields more grain, if care be taken to select good seed, than does corn that is brought from other locality. This being the case there is every reason why seed should be selected for raising ensilage corn, and why it should be produced in the region of which the ensilage is to be grown rather than to be brought from some other part of the country.



A *B*

FIG. 358.—*A, Ear with shallow kernels. B, Ear with deep kernels. From "Examining and Grading Grains."*

The large southern varieties of corn that were frequently grown for ensilage when the silo first came into use often contained no less than ten per cent. of dry matter, the remainder being water. In words, they contained when cut for silage as little dry matter as does skim milk produced by the separator process.

There should be a medium sized stalk and a good ear on ensilage corn, and for that reason seed should be selected with both of these points in mind. Pick the seed in the fall before freezing weather sets in. Hang it in a dry, well ventilated room where it can be thoroughly dried before freezing, or where it can be kept warm enough not to freeze. Freezing does not injure the germination of corn unless the grain is moist. If the grain is perfectly dry, corn may be subjected to very low temperatures without injury.

Experience throughout the "corn belt" has shown that the yield of corn may be greatly increased by planting from ears that possess certain qualities. These are:

1. A cylindrical shape. (Fig. 357, A.) An ear of this shape carries more grain and has more uniform kernels than a tapering ear. An ear

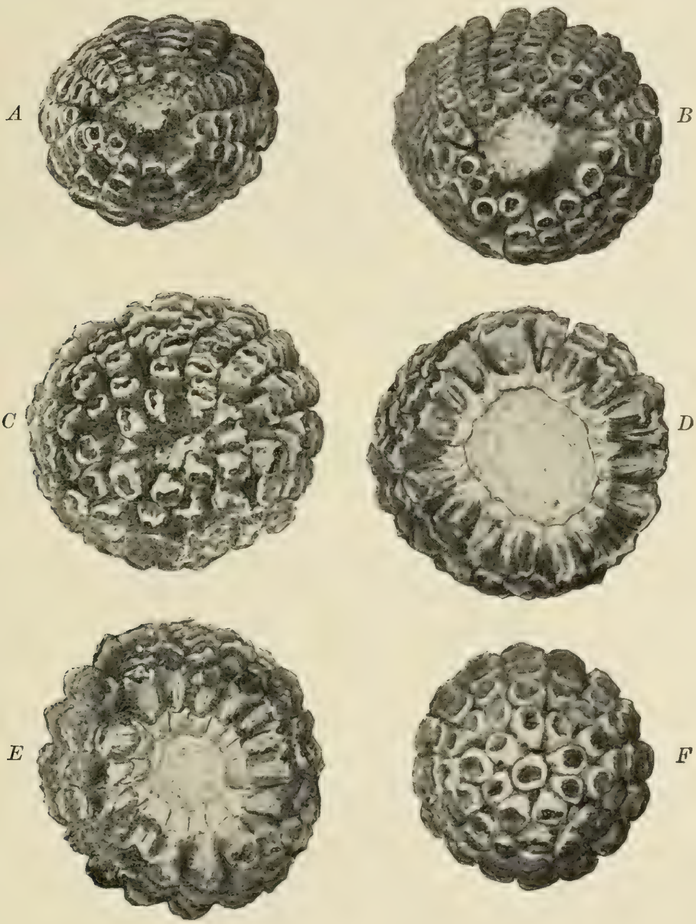


FIG. 359.—*A and B, Poorly filled tips. C, Poor butt, shank too small. D, Poor butt, shank too large. E, Well filled butt with shank of proper size. F, Ideal tip. From "Examining and Grading Grains."*

may taper because the kernels grow shorter toward the tip (Fig. 357, C), or because some of the rows of kernels drop out between the butt and tip (Fig. 357, B). In either case there is less grain produced than there would be were the kernels deep throughout the ear or were the missing parts of rows present.

2. An ear of medium size. One important thing to bear in mind is that the very large ears of corn are not, on most soils, the best to plant for seed. The larger the ear the greater the amount of fertilizing matter and the longer the growing season required to produce it. If a large eared variety or strain of corn is planted and either of these factors are deficient the result is a smaller yield of grain than if a medium sized ear had been used. It is, however, desirable to have the largest possible amount of grain on an ear of medium length.

3. A moderately deep kernel. It is obvious that as between two ears otherwise similar the one with the shallower kernels will have the less grain. A good illustration of this may be had by finding two ears, one with deep (Fig. 358, B) and one with shallow kernels (Fig. 358, A), but with the same number of rows of kernels and with cobs of the same length, shelling them and weighing the grain. Note the difference in the weight of grain.

A deep kernel is almost always rough on the cap, and a shallow kernel is smooth. Hence a desirable ear of seed corn will be somewhat rough on the surface.

A deep, rough kernel requires a longer growing season than does a shallow, smooth one. There is, therefore, a limit to the depth of the kernel that can be grown in any locality. The shorter and cooler the growing season the shallower the kernel that it is possible to produce. In selecting seed, do not take an ear with kernels so deep that they are chaffy. Such an ear will not sprout well, giving a poor stand of corn, and it will produce grain that will not fully mature. Avoid, on the one hand, a very shallow kernel, and on the other a chaffy one. If the cob can be twisted in the hands or if the kernels are quite loose on the cob the ear has not ripened fully.

4. Tip well filled out. It is desirable to have the kernels run well to the tip of the corn. The extent to which the ears are filled out will depend to some extent, on the season and the soil as well as upon the inherited qualities of the plants, but in order to be sure that you are not selecting ears from plants with an inherent tendency to produce poor tips it is well to discard such ears, and to take only ears that are at least moderately well filled out. (Fig. 359, A, B, F.)

5. Butt well rounded out. The butt should be well filled with good sized kernels. (Fig. 359, E.) The shank, which holds the ear on the stalk should not be excessively large (Fig. 359, D), as such an ear dries out slowly and is more apt to be injured by the frost than one with a smaller shank. On the other hand a very small shank is apt to break off during a very heavy wind, and the ear is then lost. (Fig. 359, C.)

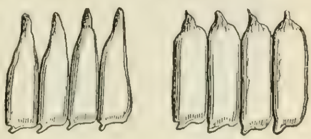
6. Properly shaped kernels. The shape of the kernel should be taken into consideration, and to facilitate the consideration of this character, a

few kernels should be removed from the center of the ear, and their shape and uniformity examined. The kernels should not be square, because they leave wide spaces between the rows. (Fig. 360, C.) They should not be round for the same reason. (Fig. 360, B.) They should not be too pointed, for that interferes with their proper development. A proper slant to the sides of the kernel like that of the keystone of an arch, will permit the kernels to fit close together around the cob, and thus occupy a minimum space. This shape and compact arrangement of kernel appears to be correlated with great depth and weight of kernel. (Fig. 360, A.)

The narrow side of the kernel is also to be considered. On this side the edges should be parallel from crown to base. (Fig. 361, A.) A kernel pointed on this side is objectionable for the same reason as is one pointed on the broad side. (Fig. 361, B.)

A B C

FIG. 360.—*A, Kernel of proper shape. B, Round kernel. C, Square kernel. From "Examining and Grading Grains."*



A B

FIG. 361.—*Kernels fitting closely from crown to tip. Kernels pointed on narrow side. From "Examining and Grading Grains."*

The necessity for uniformity in the kernels arises when a planter or drill is to be used. It is impossible to make a machine drop the same number of kernels in the hill or at given intervals in a row unless they are of approximately the same size and shape. The best yields of corn are to be obtained only from a perfect stand, hence the importance of planting accurately.

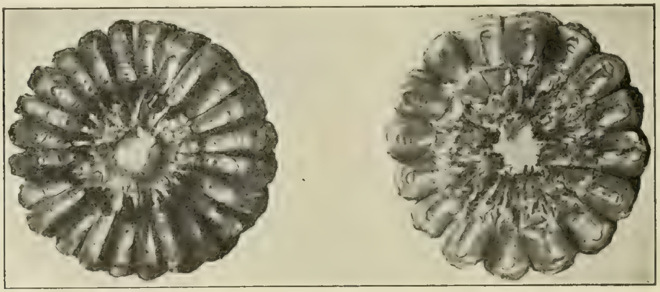
7. Moderately small cob. A very large cob dries out slowly, and such an ear is more likely to suffer from frost. (Fig. 362, B.) A moderately small cob is preferable. (Fig. 362, A.)

Test all seed corn before planting to see if it will sprout well. There is a great advantage in making a test of each ear separately, and it is quite easy to do so. If any ear is found to have poor vitality it should be discarded.

To test the corn take a shallow box, fill it with one or two inches of saw dust or sand, first thoroughly wetting the sand or saw dust and allowing it to drain out by hanging it up in a sack for a half hour or more. It will then leave about the right amount of moisture. Cover the moistened material with a piece of muslin, and mark off the surface in rectangles about 2 x 1½ inches in size. Number the spaces consecu-

tively from one upward. Take six kernels from each ear, two from near the butt, two from the middle and two from near the tip. Place the six kernels on one of the numbered squares, and mark the ear with a corresponding number. A rubber band is a convenient thing to put around the ear to hold a slip of paper with the number written on it. Sample and mark all of the selected ears in this way.

After all of the spaces have been filled place a piece of muslin over all of the kernels. Then take a larger piece of muslin, put damp sand or sawdust in it and so lay it in the box that all of the kernels are covered. The grain will thus be kept in contact with a sufficient supply of moisture,



A *B*

FIG. 362.—*A, Moderately small cob. B, Large cob From "Examining and Grading Grains."*

and no more need ordinarily be added, at least to the lower layer of sand or sawdust, during the test. (Fig. 363.)

Place the box in a room where the temperature may be kept at nearly 80° F. The kitchen generally comes nearest to this requirement, but care should be taken that it does not get too hot during the day nor too cool at night. Lift off the muslin cover each day and remove the sprouted kernels. At the end of the sixth day, count the unsprouted kernels. Any ear having more than one unsprouted kernel should be rejected for planting.

There is a prevalent opinion that it is desirable to send to a distance for seed corn. This is a mistake. Experiments have shown beyond doubt, that corn must become acclimated before it can give its maximum yield.

There is no need of a variety of corn "running out." The so-called "running out" is due to careless seed selection and depleted soil, but in any case it is better to raise crops continuously from one's own seed rather than to depend on seed from a distance.

There is also a tendency to try new varieties, or so-called new varieties, without any knowledge of their adaptability to the soil and climate of this section. Much disappointment is likely to result from

this, particularly if the seed be brought from the "corn belt" where the soil is very fertile and the growing season long and hot. Any new variety should be tried only in a small way the first year. Much time and money are wasted every year in growing varieties of corn whose only recommendation is that they have new names.

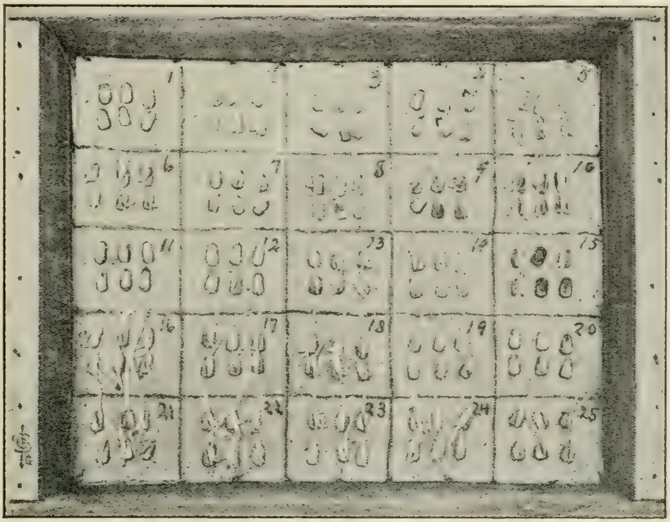


FIG. 363.—*Box for testing seed corn to find out which ears are fit to plant. From Iowa Experiment Station Bulletin.*

TO THE READER:

If you are interested in this Bulletin, you should secure other literature which will add to your knowledge of the subject. The Reading-Course Bulletins are designed merely to introduce the subject. They are brief and elementary; you should supplement them with reading from other sources. We do not care to recommend certain books and bulletins over other publications on the same subject; but in connection with the subject considered in this Bulletin we believe that you will find the following publications of the U. S. Department of Agriculture, Washington, D. C., of special interest. These are sent free:

Farmers' Bulletin No. 253.
Farmers' Bulletin No. 229.
Farmers' Bulletin No. 199.
Farmers' Bulletin No. 32.
Experiment Station Work No. 4.
Experiment Station Work No. 7.
Experiment Station Work No. 9.

SUPPLEMENT TO
CORNELL
Reading-Course for Farmers

PUBLISHED MONTHLY BY THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS JULY 16, 1894
L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING. — ITHACA, N. Y., FEBRUARY, 1907. — No. 34. CORN AND SILAGE.

SUPPLEMENTAL DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 9

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) *We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons.* (2) *We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.*

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT TO THE RECEIPT OF THE BULLETIN. *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this discussion-paper then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public. As the Discussion-paper will contain written matter, it will require letter postage.*

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The purpose of this Bulletin is to discuss briefly the generally accepted methods of seed corn selection, dealing in particular with dent corn for the silo. The following questions and directions will help in studying the problem:

1. Why should seed corn be protected from freezing while it is moist?

2. If you have had any experience with southern grown seed corn, describe it.

3. Take two ears of corn of the same length, and leaving the same number of rows equally well filled out on the tips, but one ear having shallow and the other deep kernels. You can ascertain the depth of the kernel by breaking the ear in two. Shell and weigh on store counter scales the kernels from each ear. Record the weights of each.

4. If one ear of corn is cylindrical and another tapering, although both of the same length and the same thickness at the butt, which will have the greatest amount of grain and why? Pick out such ears, shell, weigh the grain and record the weights.

5. Break a number of ears of corn in two. Pick out ears with square kernels; round kernels; pointed kernels. Notice the space left between the rows both at the caps of the kernels and along the cob. Compare with kernels that fit closely all around the cob. Estimate the loss of space in each.

Shell off several rows of kernels from a number of ears. Look at the side of the kernels exposed. Notice that some ears have space between the kernels at their bases, while others do not. Estimate the loss of space in those having large spaces.

6. Take an empty cigar box, partly fill with moist sand or sawdust. Cover with muslin marked as already described. Place muslin with moist sand or sawdust on top. Follow directions before given for making germination test. Record each ear by number and the number of kernels from each ear that failed to sprout. If you have any corn that has been hung up in a dry place, or kept in the house over winter, test this as well as some that has been left in the crib.

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L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING. | ITHACA, N. Y., MARCH, 1907. | No. 35. FIGHTING FUNGI.

FIGHTING THE FUNGI IN THEIR WINTER QUARTERS.

SOME THINGS THAT MAY BE DONE NOW TO SAVE THE COMING CROPS.

[*Supplement to Bulletin 14.*]

BY H. H. WHETZEL.

Much may be done in the early days of spring before the full rush of farm work comes on, toward the destruction of many of the common fungus pests which annually reduce the profits of the farmer. Many of the disease-producing bacteria and fungi pass the winter in such a condition as to be very readily disposed of, if attacked before they have passed from the dormant state. Many of them pass the winter in an inactive condition in the bark of trees or in the seeds of the plants that they had affected the previous season.

It is the purpose of this paper to remind you of some of the more common and destructive of these diseases, also to indicate some things that you may be doing, at odds and ends of time during the coming days of March and April, towards their destruction.

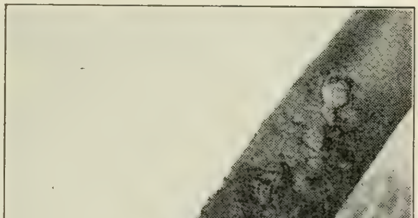

FIG. 364.—*Typical New York Apple Tree Canker showing the rough and swollen bark.*

THE ORCHARD.

It will be well to make a careful inspection of the trees in the orchard to see if you cannot find some that need attention. You are fortunate indeed if some one of the following diseases is not present.

The New York Apple Tree Canker.—This is a common canker disease in Western New York. Examine the main limbs of your apple trees, especially on the upper side. If they have large, black roughened areas like that shown in Fig. 364, you may be quite sure it is this disease. Twenty Ounce, Baldwin, Wagener, Greening and King trees suffer most from this Canker. This is a fungus disease. You can often make out the little pimples or fruit bodies of the fungus scattered over the surface of young cankers. (Fig. 365.) The spores are scattered from these cankers to leaves and sometimes to fruit causing what is known as "black rot." If the limbs are badly affected it may be necessary to cut them out entirely. If the cankers are small they may be removed by cutting well back into the healthy bark and scraping out the diseased tissue. Wash the wound with a solution of corrosive sublimate, one part to one thousand of water, and paint over with a heavy lead paint. Thoroughly sprayed orchards suffer very little from this disease and especially where an effort is made to coat the limbs at the time when the first application of Bordeaux is made for the apple scab, about the time the leaf buds begin to open. If these cankers are abundant it will be well after pruning and cutting them out to spray the trees with a strong solution of

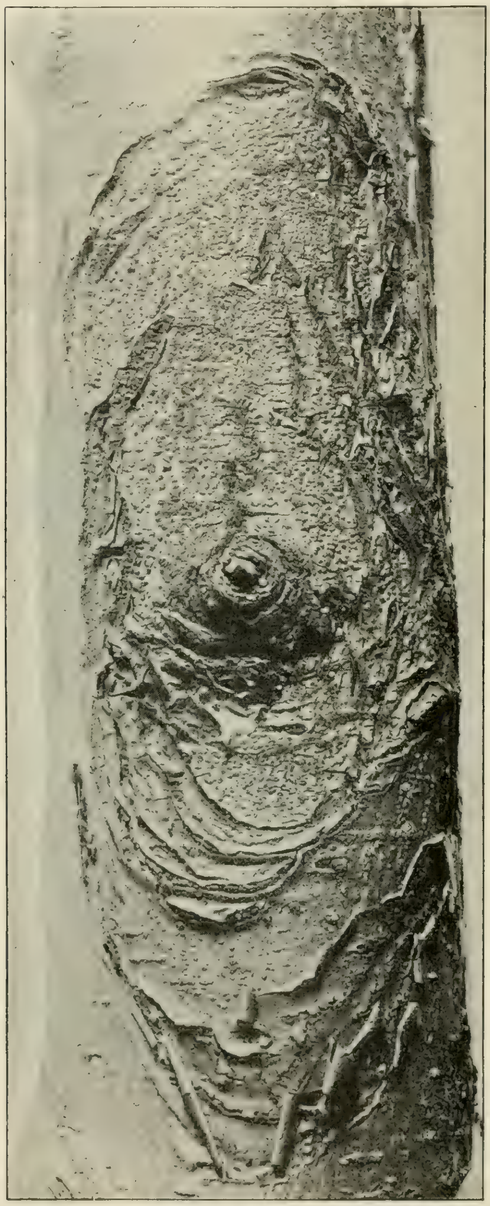

FIG. 365.—*Blight Canker developing about base of blighted twig on Greening tree.*

Bordeaux of the formulae 8-12-50 to each 100 gallons of which add the following sticker: two pounds resin, one pound sal soda (crystals), one gallon water: boil until of a clear brown color. Open up the trees by pruning to let in the light and air. Be careful not to bruise the limbs by climbing about in the trees as this makes entrance places for the canker fungus. (See N. Y. (Geneva) Bulletins 163 and 185, or Ann. Reports 1899 and 1900.)

The Blight Canker.—This is a common canker of apple and pear trees in many parts of the State. The blight cankers are caused by the bacteria of Fire Blight and are but another form of that dreaded disease. They usually appear on the body and main limbs of young apple trees just coming into bearing. They usually appear about the base of short spurs or water sprouts which have been blighted, the bacteria working their way down into the bark of the limb. (See Fig. 366.) This canker differs from the New York Apple Tree Canker in appearance, being smooth and sunken with a distinct crack marking its boundary. It is not black, the diseased area being about the color of the healthy bark. It is in these cankers that the bacteria are carried over winter, especially those on the pear tree. From these "hold over" cankers as they are called, the bacteria are carried in the spring to the blossoms and twigs by bees, causing blossom and twig blight. Now is the time to tackle this disease. Cut out and treat the cankers as described for the New York Apple Tree Canker above. Spraying the trees, after the cankers are removed with lime or sulphur wash or strong, Bordeaux may also be of some benefit. (See N. Y. (Cornell) Bulletin 236.)

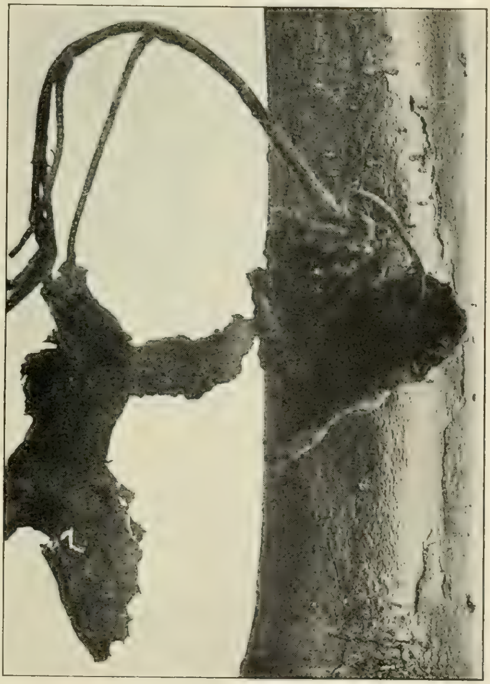

FIG. 366.—*Early stage of New York Apple Tree Canker showing the tiny black pimples or fruit bodies of the fungus scattered over the surface.*

The Leaf Curl of Peach.—The curling of the leaves of the peach trees shortly after they unfold in the spring is familiar to nearly every

one who has grown peaches. Fig. 367 will refresh your memory. Frequently this is very destructive, causing the tree to lose its first set of foliage and compelling it to put out another coat of leaves. This is a great drain on the tree, weakening it and causing the dropping of the fruit from insufficient food during its growing period. It is, however, one of the easiest diseases to control. Spray the trees any time in the spring before the buds swell, with Bordeaux or plain copper sulfate, two pounds to 50 gallons of water. If you spray the trees with lime and sulphur for the scale this will also prevent the curl. DO IT NOW. For

FIG. 367—*Leaf Curl of Peach. The fungus causes the leaves to thicken and curl or pucker.*

further information on this disease see Bulletin No. 20, Division Vegetable Pathology, U. S. Department of Agriculture, and N. Y. (Cornell) Bulletins 164 and 180.

Black Knot of Plum and Cherry Trees.—You should have no trouble in finding this disease if it is on your trees. The large black knots on the small limbs and twigs stand out sharply against the winter sky. Sometimes the main limbs show the excresences also. Here is another case for the surgeon. With knife and saw carefully cut out every knot. The spores of the fungus are ripe and being scattered at this time of the year. All the pruned out knots must therefore be collected and burned. Do not neglect this and DO IT AT ONCE. (See N. Y. (Cornell) Bulletin No. 81.)

Oat Smut.—This is one of the most common of fungus diseases. It occurs every year to a greater or less degree in nearly all oat fields

unless the seed has been treated. The fact that the smut ripens early and disappears leaving nothing but the blasted stalk at cutting time, often causes the farmer to overlook its presence unless it is sufficiently abundant to attract his attention from a distance. Nevertheless, the careful examination of an oat field at blossoming time will usually show from 1 to 10 per cent. of smutted heads. The black sooty mass, familiar to most farmers, is composed almost entirely of the minute spores of the fungus. These as I have just indicated are ripened and scattered at the time the oats are in blossom. When the oat plant is in bloom the two glumes that enclose the grain stand wide open exposing the parts of the flower. Some of the smut spores carried over the field by the wind are

FIG. 368.—*The Scab of Potatoes.*

sure to fall into this open flower and lodge at the base of the grain. When the seed has been fertilized the glumes close tightly, so tightly in fact that they are not removed in threshing. The smut spore is thus enclosed along with the grain. When these oat grains are planted the next spring the enclosed smut spores are planted along with them. The spore germinates when the grain does, sending its germ-tube into the tender sprout of the oats. This grows upward into the stalk of the plants as it lengthens, finally producing its spores in the place where the grain should form.

This disease can be entirely prevented by treating the seed with formalin. Formalin is a gas dissolved in water. It can be purchased at the drug store. To 50 gallons of water add one pint of formalin. Immerse the sack of oats in the solution for ten minutes or so, shaking it now and then so that all the grains become wet. Remove the sack and allow it to stand for two hours. The grain may then be spread out on

a clean floor and dried. Most growers find it convenient to treat it just before sowing and then drill or broadcast it at once. Some pile the oats two or three bushels in a pile, and sprinkle it with the solution, using about one gallon to the bushel. The oats should be shoveled over while being sprinkled in order to wet it thoroughly. The pile is then covered with a blanket or sacks and allowed to stand for two hours. It has been found that where the farmer grows his own seed oats it will be necessary to treat the seed only every third or fourth year in order to keep the crop free from the smut. Is 5 per cent. of your oat crop worth saving? Figure up and see how much this would have meant in dollars on last season's crop. Try formalin and report to us.

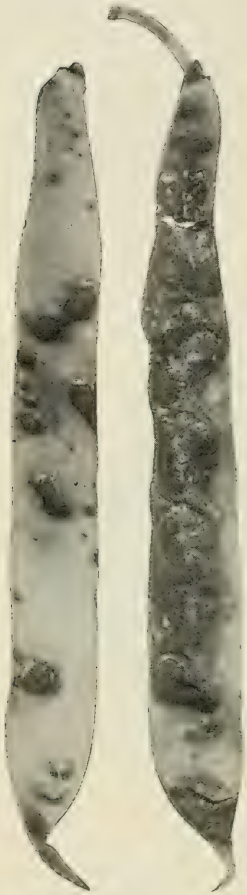

FIG. 369.—*Anthracnose or "Pod Spot." Note how the disease eats into the pod forming the black spots or cankers.*

FIELD AND TRUCK CROPS.

Potato Scab.—Are your seed potatoes smooth and free from scab? (Fig. 369.) If there are scab spots on any of them they should all be treated before planting. The scabbiness of potatoes is due to a fungus that lives on the surface of the potato, penetrating just deep enough to roughen the skin. It is carried over from year to year in two ways, on the diseased tuber or in the soil. If last year's crop was scabby do not plant on that same field again this year. The disease is in the soil. Plant some other crop there. Plan to put your potatoes on lands where potatoes have not been grown for several years. Sort out and discard the more scabby seed potatoes and treat those to be planted as follows: Add one pint of formalin to 20 or 30 gallons of water Soak the seed for at least two hours. Cut and plant, or dry thoroughly and store until ready to plant. The treated seed must be planted on soil free from the scab fungus or the treatment will be of no use. Dusting or coating the potatoes with sulphur after they are cut, is sometimes advised but this has been shown by careful experiment to be worthless. Don't forget to plant a few rows with untreated seed. You can then tell by comparison whether the formalin treatment pays or not.

Dry Rot of Potatoes.—Have you examined your seed potatoes to see how they are keeping? Perhaps you have noticed in the potatoes you are using that some of them show when cut across the stem end a circle of brown or black spots just a little way under the skin. This is the work of the "dry rot" fungus. It is a soil fungus that gets into the tuber through the stem. It usually does little damage during the growing season but spreads in the sap tubes of the tubers after they are stored. At first it does not show on the outside of the potatoes but after a time if the store room is moist and warm the stem end of the tuber begins to shrivel and turn brown with a dry rot. Many white or greenish-white warts burst through the diseased surface. These are the spore masses of the fungus. The entire rotted surface may become covered with a white, moldy growth. The fungus spreads from these rotted tubers to the adjoining healthy ones. The rotted potatoes should be sorted out and destroyed at once. The sound ones should be disposed of as soon as possible as they are unfit to plant. Many of them are sure to have the fungus in the sap tubes and while they will not be unfit for food should not be planted. If these diseased tubers are planted they will cause the next crop to suffer from the fungus and what is worse, will infect the land so that it will be unfit to plant potatoes for several years. Get seed that does not show this dry rot and plant it on clean land, land that has not grown potatoes for several seasons. There is no seed treatment that will prevent this disease. The fungus is inside beyond reach of poisons. If you are buying your seed potatoes inspect them carefully to see that you do not get the pest on your farm. It is much easier to keep it off the land than it is to rid the place of it once you get it. The constant or frequent planting of potatoes on the same land is very favorable to the increase of this disease. A four or five years' rotation should be followed.

Black Rot of Cabbage.—This disease is often quite destructive in sections where cabbage is grown on a commercial scale. It is known by the wilting and yellowing of the leaves which soon become dry and papery. The veins when the leaf is held to the light show black. The disease is caused by bacteria that get into the leaves through the water pores at the edge, travels down through the tubes in the veins stopping them up and causing the wilting of the leaf. It causes the leaves to die and drop from the stalk leaving only a small tuft or head at the top. This disease is sometimes followed by another which causes the head to become soft and rotten with a foul odor. This is known among growers as "Stump Rot," on account of the fact that the head becomes loosened and may be lifted from the stalk. It has been found that the bacteria that cause the Black Rot are often carried over on the cabbage seed.

The Geneva Experiment Station (Bull. 251) recommends that the seed be treated as follows: Soak the seed for fifteen minutes in corrosive sublimate, 1 part in 1000 of water or in formalin, one pint to thirty gallons. This will of course not prevent infection if the cabbage be planted on infected soil, that is, soil that had a crop of diseased cabbage on it last year. Treat the seed NOW and then plant on clean soil. Don't forget the seed bed either. It should be on soil free from the germ. A little thought, time and money may save your cabbage crop next year.

Bean Anthracnose.—Did you lose your bean crop last year from the spots that came on the pods, ruining them? (Fig. 369.) You very probably had the disease and suffered a reduced yield at any rate. This is a fungus disease and occurs on practically all beans grown in the State except the Limas. It is the greatest enemy of the bean grower. No varieties are entirely proof against it, all claims of the seedmen to the contrary nothwithstanding. Some it is true are much more resistant than others. The disease is carried over in the seed. Although I have examined many samples of bean seed during the last year I have never found one that was free from the anthracnose. Much of the seed offered on the market shows as high as 50 per cent. diseased as determined by careful germination tests. Well what is to be done you ask. In the first place test your seed to see how badly diseased it is. Write to me for directions or send me some of the seed (half a pint) and I will test it for you. While it will not be possible to hand pick the seed so as to get rid of all the disease, still it will pay you to remove the affected beans as well as you can, as this will give you a better stand of strong, healthy plants. Now is the time to do this hand picking. You won't have time when the rush of planting is on. This is a good job for rainy days. If the test shows the seed to be badly affected, better get other seed if you can obtain any that is cleaner than your own. And lastly plan to grow your own seed hereafter. Let me send you a plan for a seed patch and method of selecting seed from it free from the disease. If you plant seed absolutely free from the disease you will have no pod spot in your beans no matter what the weather may be.

SUPPLEMENT TO

CORNELL

Reading-Course for Farmers

PUBLISHED MONTHLY BY THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS JULY 16, 1894
L. H. BAILEY, DIRECTOR.

SERIES VII. HELPS FOR READING.	ITHACA, N. Y., MARCH, 1907.	No. 35. FIGHTING FUNGI.

SUPPLEMENTAL DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 14

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) *We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons.* (2) *We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.*

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT TO THE RECEIPT OF THE BULLETIN. *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this discussion-paper then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public. As this Discussion-paper will contain written matter, it will require letter postage.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. *The Farmers' Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.*

THESE BULLETINS CAN NOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

Much of the profit of the summer's work depends upon a wise and carefully planned beginning in the spring. The farmer is sure of meeting certain plant diseases that must be controlled if his crops are to do well. This bulletin calls attention to some of the more common plant diseases on the farm and points out remedies for their control. The following questions may help in studying this subject.

1. What fungus diseases have you observed in your orchard this last season?

2. What has been your experience with the New York Apple Tree Canker?

3. Judging from the cuts in this bulletin does the Blight Canker occur in your section? Do pear trees suffer from Fire Blight? What varieties?

4. Have you ever sprayed for Leaf Curl of peach? How and with what success?

5. What is the most serious fruit disease in your section? What is done to control it?

6. What is your opinion of seed treatment to prevent oat smut? Upon what is this opinion based?

7. In trying different remedies to prevent fungus diseases do you leave untreated rows as checks to determine the value of the treatment? Why?

8. Give us your experience in treating potatoes for scab? Have you ever tried sulphur? With what success?

9. Have you ever treated the seed for Black Rot of cabbage? Was it successful?

10. Have you ever sprayed beans to prevent Anthracnose or Pod Spot? With what result? Did you leave check rows untreated?

Name......................................

Date......................................

County.................. Postoffice.............................

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please write us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

CORNELL

Reading-Course for Farmers' Wives

PUBLISHED BY THE NEW YORK STATE COLLEGE OF AGRICULTURE, AT CORNELL UNIVERSITY, FROM NOVEMBER TO MARCH AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, Director.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES V. ITHACA, N. Y., NOVEMBER, 1906. No. 21.

SUGGESTIONS TO READERS.

For four years formal bulletins have been sent to the members of the Farmers' Wives' Reading Clubs and we know have our fifth year readers who have graduated from the reading of these special studies, to whom we shall send now and then greetings and suggestions for further thought and occupation. While we may not send to them the same kind of bulletins as formerly, we desire to keep in touch with their lives and to have the opportunity of suggesting outlines of study and reading which will continue the home culture. The time does not come when we are ready to lay down the book, fold our hands, and consider the improvement of life at an end. One of the most beautiful pictures in life is an aged person finding happiness in an open book.

The report of the Reading-Course for Farmers' Wives, November 1st, 1906, shows the following membership:

Series	1.	New Readers	194
"	2.	"	2046
"	3.	"	6861
"	4.	"	4460
"	5.	"	6952
	Total		20,513

The interest in the Reading-Course work has been very active even on the part of those who did not regularly fill out and return the Discussion-papers, as the following letters indicate.

Letters from Members.

In answer to question as to why the Discussion-paper is not returned:

"I consider the Reading-Course of great value to me, and it is through no lack of interest that I have never returned the Discussion-papers, but because I have not had the strength or time, or have neglected to do so, not having many new ideas to pass out."

"I must say that your question blanks are very interesting. The reason for my not returning them is that I am doing my own housework, and with quite a family to do for, neglect to write, that is all."

"I enjoy these Reading-Courses very much, if I am slow about answering. I read them all, but there are so many others that are able to answer these questions so much better than I, that my papers are not of much account, but I would like the course next winter to study just the same."

"Your Reading-Course is of the greatest value and most benefit to me of any book or magazine that I have read. Without it I would be lost. I have read and saved every Bulletin you sent to me. I am a very poor hand for writing, and this is the only reason for my not answering your Discussion-paper, but my not returning it does not infer that it is of no special interest to me, for I think very highly of it.

"Hoping you will continue sending it to me, and thanking you in advance, I remain."

"Illness and a multiplicity of cares have prevented me from answering the questions accompanying the Bulletins for the Farmers' Wives the past year as I ought, so take this opportunity of writing you, for I know your work is *work,* and should be appreciated. Really think it is, as I was with a meeting of our ladies last week after returning home, and heard them discussing what they had learned from reading up the different leaves, with the questions on the Discussion-papers. It was really very interesting and instructive. Only wished you could have been close by to have heard it, and hope no one of them have neglected to answer and send on the questions like myself, for I do think I hardly merit your kindness in still sending them to me.

"Hope I may have time to read up and send on the back leaflets. Hoping you may see the fruits of your labor, I am."

"I have been much interested in your Bulletins received from time to time, and more especially so in those relating to household affairs and the garden necessarily since my home is in Fredonia. Being bred on a farm, though all my life a teacher, the entire subject appeals to me. I regard your papers on the arrangement of furniture, saving of steps, household adornment, and all the internal economy of the home invaluable, and wish they might reach not only the farm houses, but every village and town home.

"Then, too, you have opened to me a line of connection with the University from which I have received much valuable information, of use in my garden, and on my lawn and trees. Many other things which, naturally, I do not need, are admirable for the class for which they were designed, and I congratulate you most heartily on the success of the course."

"I have received the Reading-Course for Farmers' Wives, and have got a great many helpful things from them. I am sorry that I have not had the time to answer the questions, but I have so much writing to do, with my other work that my time is nearly all taken up. I am Secretary for our Grange (122 members), which makes me lots of writing. My husband has business that I do lots of writing for him, and with writing letters to friends and relatives, makes about all the writing I have time for. We take a number of papers, and I try to keep up with local affairs. I have enjoyed the Reading-Course very much if I have not answered the questions, and they have been of very much interest to me. Two years ago we tried to start a club, and study the papers, but it some way did not materialize. Every night we had set to meet it would storm, and we could not go. If you see fit to continue sending me the papers I shall continue reading and enjoying them, and shall be much obliged."

"As one of the members of the Reading-Course for Farmers' Wives I want to tell you how much I have enjoyed the past year's work. I feel that it has met a long felt want in the lives of the farmer's wives. As for myself, I began farming last year. Most of my life has been passed in town, and when I came on the farm, and saw the old house, and the general tumble-down appearance of it all, I thought I could not stay, but I am becoming very much interested in the farm, for the many helpful ideas and bright suggestions gained from the past year's study have enabled me to make the old house a comfortable and cheerful home to dwell in, and I am looking forward with glad anticipation to the time when many more conveniences will be added. I think I may safely say that the Reading-Course is the first real help to higher living that the farmers' wives of this vicinity have ever enjoyed, and it has been faithfully studied, and truly appreciated.

"We are planning for more thorough work next year. We mean to make use of the state library provision.

"I wish to express to you my own gratitude for the help and enjoyment I have received."

FARMERS' WIVES' CLUBS.

The Reading-Course for Farmers' Wives is first for the individual reader, second for the company of readers gathered together for mutual help and suggestion in the form of Farmers' Wives' Clubs. These clubs we wish to report to some extent in this leaflet.

The Auld Lang Syne Reading Club is one of uncommon interest. Near the village of Williamsville on the road from Buffalo to that village is a brick school house not far from the trolley line. It replaced the building known as the old red school house where a woman for several years taught the boys and girls of that country neighborhood not only the usual subjects found in the school program but many other things which rare and good teachers give to the young people entrusted to their care. These pupils grew up to manhood and womanhood and many of them settled on farms in that locality; others have become residents of the city of Buffalo, and still others have moved farther away.

Believing that the years spent in the school room are not all one's education, this teacher, after others had taken up the school room work, became the leader in thought and study among her friends and neighbors who as children had been her pupils, with now many gray heads in their membership. The club has been organized to pursue reading and study at home with the same leader that they had in their childhood days. Regularly once a month a meeting is held, with a program full of interest and enthusiasm, with part of the work suggested by the Cornell Reading-Course. The Supervisor of the Reading-Course for Farmers' Wives had the pleasure of visiting the club last summer, listening to an entertaining program, engaging with the members in a delightful social hour, and a repast brought and prepared by the members. Before the close of the meeting the members passed around the room shaking hands with each other, and singing:

> "So here's a hand my trusty friend,
> And give a hand of thine;
> We'll pledge a life-long friendship
> For the days of auld lang syne."

Following is the formal program of this club:

THE AULD LANG SYNE STUDY CLUB.

1899—1906-7.

ORDER OF BUSINESS.

Club Song.
Roll call with quotations.
Reading of Minutes.
Business period.
Program.

OFFICERS.

President ....Miss ESTHER E. WITMER
Vice-President ....Mrs. MAY W. PARDEE
Secretary ....Miss MAY BELLE MILLER
Treasurer ....Mrs. AMANDA FOGELSONGER

The Club Members are expected to study the Cornell Lesson Leaves and discuss questions on the subjects treated therein.

SEPTEMBER—SECOND THURSDAY.

Hostess, Mrs. EMILY SCHMITT, Niagara Falls.

President's Address ....Miss Esther Witmer
How we spend our summer vacation..........................By the Members
Current Events ....Leader, Mrs. Mary Reist

OCTOBER—SECOND THURSDAY.

Hostess, Mrs. ELIZABETH PETERS.

Talk on Baking..........................Mrs. Maggie Miller
History of Niagara River from Lake to Lake..........Mrs. Anna Wittigschlager
Current Events ....Leader, Miss Esther Frick

NOVEMBER—SECOND THURSDAY.

Hostess, Mrs. CARRIE WITMER.

Paper—"Longfellow" ....Mrs. Mary Weil
The Mayflower's Passengers..........................Miss Grace Witmer
Current Events..........................Leader, Mrs. Kate Long

DECEMBER—SECOND THURSDAY.

Hostess, Mrs. ANNA MAGOFFIN.

How and when to rest..........................Mrs. Elmira Frick
What to do when unexpected company comes—Open discussion–Leader, Mrs. Ella Hillman
Pronunciation Drill ....Leader, Mrs. Mae Pardee

JANUARY—SECOND THURSDAY.

Hostess, Mrs. Fannie Frick.

Helen Keller..Mrs. Elvira Zavitz
Maxims for the New Year..By the Members
Current Events..Leader, Mrs. Marie Miller

FEBRUARY—SECOND THURSDAY

Hostess, Mrs. Mary Dechert.

Club Paper—First Edition..Editor, Mrs. Mae Pardee
Valentines..

MARCH—SECOND THURSDAY.

Hostess, Mrs. Katie Kipp.

Books that help..Miss Esther E. Witmer
Noted Artists..Miss Esther Frick
Current Events..Miss Eva Long

APRIL—SECOND THURSDAY.

Hostess, Mrs. Elvira Bates, Williamsville.

Paper—Cathrine Booth..Mrs. Anna Magoffin
What labor saving device have I found most useful in my housekeeping experience—Open discussion...........Led by—Mrs. Katie Kipp
Current Events..Leader, Mrs. Mary Weil

MAY—SECOND THURSDAY.

Hostess Mrs. Amanda Fogelsonger, Williamsville.

Spring Gardening..Mrs. Ella Hillman
Shakespeare..Mrs. Anna Richardson
Current Events..Leader, Mrs. Mary Dechert

JUNE—SECOND THURSDAY.

Hostess, Mrs. E. Longnecker.

Our Boys—How we should treat them....................Mrs. Vinnette Witmer
Famous Singers and Songs....................Mrs. Clara Browning
Current Events..Leader, Mrs. Fanny Frick

JULY—SECOND THURSDAY.

Hostess, Mrs. Kate Long, Pine Ridge.

Summer Diet ....Mrs. Eva Long
Canning and Preserving—Open discussion....Led by Mrs. Amanda Fogelsonger
Pronunciation Drill ....Leader, Mrs. A. L. Rinewalt

AUGUST—SECOND THURSDAY

Hostess, Mrs. Anna Witmer.

Annual Report of Secretary.
Annual Report of Treasurer.
Election of Officers.

Solo ....Mrs. Clara Browning
Readings ....Miss Grace Witmer, Miss May Belle Miller

It is not uncommon to do the work of the Reading-Course in connection with the Grange. Here is a letter from one Grange:

"We would like to report our Farmers' Wives' Reading Club in connection with Yorktown Grange No. 862, as our meetings are held during the Grange meetings and it is our aim to make the Grange more interesting and helpful. We hope next fall to do the work as laid out in the program you sent me and feel that a good many more of our Grange members will take it up then, for as yet only about one quarter of our sisters have become interested enough to join the club. Do we use the same programs next fall and the same bulletins? We do not hold any meeting in the Grange from the middle of June till about the first of September. So our club will have to rest over, too. If there is any reading matter to be sent out during the summer months, I think all the members of our club would be glad to receive it. We thank you very much for your kind offer of help and doubtless you will hear from us often, as it is an entirely new undertaking to all of us."

This meeting shows in a strong degree the intention of the Farmers' Wives' Reading Clubs,—an instructive program, the study of home topics, special and uplifting influences and the benefits to be deprived from discussion one with another of problems common to all home makers.

The program of the club for the next year will be of interest. We shall be glad to print from month to month programs and accounts of other clubs, if they are reported to us.

MRS. CHARLES A. BUSHELL.

ANOTHER WORK FOR FARM WOMEN.

A series of Women's Institutes under the direction of the New York State Department of Agriculture, F. E. Dawley, Director, and the New York State College of Agriculture at Cornell University, L. H. Bailey, Director, have been held in the following places:

Akron, Erie County	Oct. 31–Nov. 1
Webster, Monroe County	Nov. 2–3
Hannibal, Oswego County	Nov. 5–6
Clifton Park, Saratoga County	Nov. 7–8
Rhinebeck, Duchess County	Nov. 9–10

These institutes are similar to the Farmers' Institutes of the state. The speakers were: Mrs. Helen Wells, Syracuse, N. Y.; Miss Martha Van Rensselaer, College of Agriculture, Cornell University; Miss Gertrude Gray, Toronto School of Domestic Science; Miss Matie Dann, Walton, N. Y.

Interesting features have been planned by local committees of each town, consisting of music, papers and exhibits of home work.

These institutes are similar in character to those started in Canada six years ago, and which have been very successfully conducted on in that province. It is an initial effort in New York State and it is expected thaι the experiment will prove them to be of so much value as to make them a permanent feature of state agricultural work.

WINTER-COURSE IN HOME ECONOMICS.

The woman's work in the Extension Department at Cornell University has not stopped with the printed bulletin and the correspondence work, but has sought to bring farm women, especially the young, to the University for a Winter-Course in Home Economics. For several years the College of Agriculture has had its Winter-Course for men, and with the belief that the home problems are as great and of as much importance as those outside the house, it was arranged last winter to provide a Winter-Course for home makers. The initial effort was most satisfactory to all interested. Some of the most eminent women teaching Domestic Science in the institutions of the country were brought to Cornell University as lecturers, and forty-two regularly registered, together with as many more visitors each day listening to their instruction. Other states have striven for the same end, but few have been able to secure as much as has been offered the women of the state of New York.

Beginning Dec. 6th, 1906, another Winter-Course for women and men is provided in Home Economics. In these pages we give an outline of the courses of study and invite correspondence from the farm homes of the state where there is interest in this course relative to the sending of daughters or sons to Cornell University for this winter's work.

The first Winter-Course in Home Economics was given last winter (January to March, 1906). It was successful in every way, for the beginning of an innovation. It included in its faculty some of the best lecturers from the best institutions in the country. It was much more largely attended than was anticipated.

Persons attending the course as students, were:

1. Young women who were interested in the art of home-making.

2. Some who were interested to get a broad view of the subjects pertaining to Home Economics with the intention of deeper study for purposes of teaching.

3. Home makers who desired to become acquainted with the newest ideas governing home life.

4. The wives or sisters of men in attendance on the other Winter-Courses, who found it convenient to attend the winter sessions together.

The course for the present winter (1906–7), will be more concrete than the former one, with fewer teachers and fewer general subjects, but with more personal work and an effort to go farther in the various topics.

If there is a possibility that you may attend the Winter-Courses, we shall be glad to hear from you and will answer questions which you may wish to ask concerning the course.

Do not make a mistake concerning the dates. In previous years the Winter-Course has opened the first of January. This year it begins December 6, and closes a month earlier.

Registration.—On Thursday, Dec. 6, 9 to 11 A. M., report to the instructor in charge of your work for registration. This is simply the mapping out of the work which you are to take during the winter.

Expenses.—Tuition is free to residents of New York State. Practically the only expense is the cost of living in Ithaca and the railroad fare to and from Ithaca. Satisfactory table-board can be secured in Ithaca, within five to ten minutes' walk of the campus, from $3.50 to $4.50 per week. Comfortable rooms near the place of boarding may be had at $1.50 to $2.50 per week, when two persons occupy the rooms, and $1.50 to $3 when one person occupies the room.

All the courses are open to both men and women of seventeen years of age and upwards. A number of women have taken the work in the other courses; and as men are interested in home-making, the course in Home Economics is well adapted to them.

THE COURSES.

The work in Home Economics for the winter of 1906–7 will be thrown into three parallel courses or lines of instruction, each requiring one or two hours each day except Saturday. Courses 1 and 2 are required. These Home Economic Courses are to be given by different experts, as scheduled below.

Course 1 has to do with underlying scientific subjects, as food, sanitation, cookery.

Course 2 considers household practice and art.

Course 3 is devoted to industries that may be added to the farm-home.

COURSE I.—One Hour Daily.

Miss RACHEL HARTSHORN COLWELL, Teachers College, New York City. Formerly in charge of Domestic Science, Michigan Agricultural College. December 10-21.

Practical Physiology and Personal Hygiene, with a brief discussion of Sanitation and Food Nomenclature.

These lectures are a foundation for the remainder of the course. They will include a discussion of those principles of Physiology and

Chemistry which are essential to a more complete understanding of that which tends toward better body efficiency, such as the cell in its relation to the complex human system; a study of the digestion of foods with experimental demonstrations; metabolism; the composition of food and its relation to the needs of the body. Those factors which are essential to good health and the limits within which they can be varied; discussions of air and water as they affect the body; ventilation and plumbing, clothing, rest, recreation and certain definite problems in personal hygiene.

Blackboard charts and experimental demonstrations will be used whenever they will bring out more clearly the points under consideration.

Miss HELEN M. DAY, Teachers College, New York City. December 26–January 4.

Scientific Side of Laundry Work.—Three lectures.

Hygiene of clothing and the properties of the fibres that influence the selection of fabrics for various purposes and the method of treatment in the laundry. The effect of heat, acids and alkalies on the different fibres will be shown by means of experiments. This is followed by the consideration of what is to be removed and the means to be employed. The chemistry involved in the processes will be illustrated by experiments when possible. Hard and soft water, soap, starch, bluing and regents for the removal of stains will also be discussed. The economic side of the question will be touched upon. The means of securing the best results with the least expenditure of force, labor saving machinery, the possibility of the removal of laundry work from the home, the necessity of boiling clothes as a means of disinfection in case of contagious diseases.

Household Bacteriology.—Four lectures.

Bacteria the cause of diseases, the ways in which diseases are spread and the means of preventing distribution. Other bacteria, yeast and molds, as the housewife's enemy in causing the decay and spoiling of foods and other material, her friend in producing other desirable changes in foods, as in the making of bread or the ripening of cheese.

Miss FLORA ROSE, Teachers College, New York City. Formerly in charge of Domestic Science, Agricultural College, Manhattan, Kansas. January 7-18.

Miss ABBY MARLATT, Technical High School, Providence, R. I. Food and Nutrition. January 21–February 1.

Miss ANNA BARROWS, Boston, Mass., Lecturer in Farmers' Institutes, Teachers College. February 4-27. Three lectures each week.

Foods and Cookery.—Illustrated by demonstration of two or three dishes, that will be prepared in each period.

By a previous study of the government bulletins mentioned below the pupil will be better able to understand the processes outlined in each

lesson. The recipes used may be found in the Home Science Cook Book by Miss Barrows and Mrs. Lincoln: 1. *Uncooked Foods.*—Functions and Uses of Food, Circular No. 46, office of Experiment Stations, C. F. Langworthy. 2. *Effect of Fire and Water.*—Canned Fruits, etc., No. 203.* 3. *Classification of Foods.*—Principles of Nutritions, etc., No. 142. 4. *Milk.*—Milk as a Food, etc., No. 74. 5. *Eggs.*—Eggs and Their Uses as Food, No. 128. 6. *Fish.*—Fish as Food, No. 85. 7. *Meats.*—Meats, No. 34. 8. *Poultry.*—Poultry as a Food, No. 182. 9. *Vegetables.*—Beans, Peas, etc., No. 121. 10. *Grains.*—Cereal Breakfast Foods, No. 249. 11. *Breads.*—Bread and Bread Making, No. 112. 12. *Miscellaneous.*—Sugar as Food, No. 93. The Chemical Composition of American Food Materials, Bulletin No. 28 revised, office of Experiment Stations.

COURSE II.—One Hour Daily.

Miss MARTHA VAN RENSSELAER and others. Announcement of special lectures by visiting specialists and members of the Cornell faculty will be made as the course proceeds.

Household Art and Household Management.—Legal transactions for purchase or rent of home; selection of site; early homes and evolution of the home; layout of grounds, cellar and foundations, building material; arrangement of rooms; finishing woodwork, floors and walls; furnishing care and selection of utensils, silver and china; carpets and rugs; library; labor saving devices in housework; household accounts; entertaining; household service; instruction to waitress. The children, care, food and training; physical training; principles of the proper use of muscles to secure strength, elasticity and health without use of apparatus. One hour daily, except Saturday.

COURSE III.

Farm Home Industries.—Affords instruction in the garden, poultry husbandry and dairy and may be taken by those whose home-work demands it. It offers lectures on feeding, care and marketing of eggs and fowls, diseases of fowls; general horticulture, vegetable culture, floriculture and ornamental gardening.

Women who desire to pursue the Winter-Course in Home Economics should correspond in regard to rooms and accommodations.

Corespondence regarding the course may be addressed to

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading-Course.

*Farmers' Bulletins. All these publications if available may be obtained by addressing the Department of Agriculture, Washington, D. C.

The Extension Work of the New York State College of Agriculture at Cornell University is of the following kinds:

1. Winter-Courses at the College.
   (a) In general agriculture;
   (b) In dairying;
   (c) In poultry husbandry;
   (d) In horticulture;
   (e) In home economics.

2. Demonstrations or experiments on farms about the state.

3. Reading-Courses.
   (a) For farmers;
   (b) For farmers' wives.

4. School-work.
   (a) Junior Naturalist Clubs and Correspondence;
   (b) Children's gardens;
   (c) Home nature-study work for teachers.

5. Lectures by various members of the staff.

6. Correspondence.

The regular college teaching work covers a four-year course. Under certain conditions, students are admitted as specials, pursuing an individual course. An experiment station is part of the college.

L. H. BAILEY,
Director.

CORNELL

Reading-Course for Farmers' Wives

PUBLISHED BY THE NEW YORK STATE COLLEGE OF AGRICULTURE, AT CORNELL UNIVERSITY, FROM NOVEMBER TO MARCH AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, Director.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES V. ITHACA, N. Y., DECEMBER, 1906. No. 22

SUGGESTIONS ON FORMER READING-COURSE BULLETINS.

"To make work happy and rest fruitful is the aim of art."—*William Morris.*

Our readers this month are given an opportunity to reflect on a work of art and to study a reason for liking the picture. Will you choose a

Photograph by Enos Mills

FIG. 189.—*A winter landscape.*

picture in your own home, or secure one, and tell us why you like it and what in it appeals to you? If you have not a printed picture that you wish to describe, choose a picture out-of-doors.

Longfellow's advice to Mary Anderson who became a great artist was each day to study a beautiful picture, read a beautiful poem, hear a fine piece of music, or study a bit of natural scenery. This is good advice to the worker in any field, for each day in which this is done is less spiritless and more worth while.

WHAT MAKES A PICTURE BEAUTIFUL?

By CHARLES DEGARMO

A reflection on the common picture of

Psyche, the Soul.

FIG. 190.—*The classical picture of Psyche, The Soul. To illustrate the discussion of the meaning of pictures.*

"One impulse from a vernal wood
May teach you more of man,
Of moral evil and of good,
Than all the sages can."—*Wordsworth.*

"My love for nature is as old as I."—*Tennyson.*

"Come forth into the light of things,
Let nature be your teacher."—*Wordsworth.*

What does Psyche* see in the pool? Glinting sunbeams among the ripples perhaps. This can hardly be, else her expression would be gladsome, not grave. Minnows darting here and there in the water? Hardly, else gravity would give place to bright and eager expectancy.

Psyche is looking at herself as reflected in the water. The soul is face to face with itself. But why so grave and earnest? Should not beauty reflected in the brook give rise to joy in the beholder? We feel the thrill of artistic pleasure in contemplating the picture as a whole. Why should not Psyche have the same emotion as she gazes at her image in the water? The difference seems to be this: We see the beautiful work of art and rejoice in it; Psyche sees her whole self—its truthfulness, but also its defects; its goodness, but also its shortcomings; its knowledge and insight, but also its ignorance and prejudice; its beauty, but also its unlovely traits. We do not therefore look to see shining in her face the soul's rejoicing at a thing of beauty, much less the vanity of the coquette or the half unconscious self-appreciation of the child, but rather the seriousness of a being who contemplates herself as she really is.

But why do we find the picture beautiful? Is it not because we too see in it at least a partial reflection of ourselves, our ideals, our feelings of worthiness and unworthiness, the spirituality of our souls which yet have interests clinging to the nature about them? Why has Psyche such butterfly wings, except that the soul is so little bound by the laws of gravity, that a symbol of flying is adequate to a flight. Why do we find so fitting the purity of the water, the charm of the flowers, the serenity of the foliage, unless it be that only in such surroundings would the soul really be at home?

Some have said that beauty or ugliness belong to objects as such, and that we merely perceive the one or the other as the case may be; others have said that beauty originates in our minds, and that we throw it like a veil over whatever we will. But neither of these theories fully accounts for the beauty we see in the picture of Psyche at the pool. Plato declared that the ideal exists. Aristotle says, "Yes, that is true, but it exists in the object itself." We need to go one step farther, and say, "Yes, the

* Pronounced Sy'-kie.

ideal exists in the object, but it exists first in us and we, like Psyche, see in the object the reflection of the ideal that is in our own minds."

It is the purpose of art to help us see at least a partial reflection of ourselves in the things about us and it is at once a comforting and an inspiring thought that not alone in human companionship, but also in the contemplation of nature and art we can find the joyous reflection of our best selves, our highest aspirations, our brightest hopes. Every home should reflect the best aspects of the soul of its mistress.

WINTER READING FOR THE FARM HOME.

A SONG OF BOOKS.

"Oh for a booke and a shadie nooke,
  Eyther in doore or out;
With the grene leaves whispering overhead
  Or the streete cryes all about.
Where I maie reade all at my ease,
  Both of the newe and old;
For a jollie goode booke whereon to looke,
  Is better to me than golde."—*Old English Song.*

December, 1906, should see at least one book read and thoroughly enjoyed by each member of the Reading-Course. It may be history, a book of travel, biography, science, a novel, a poem or a religious book. What is your December contribution to your store of knowledge and culture? Twelve books a year do not require a large library space, but if rightly chosen, they will fill a mind with inspiration and sweet companionship.

Have you read a book within the month? Write on the discussion-paper your impressions. Did it give you any uplift? If not, read one that will, and let us have the benefit of your reading. A lack of time to read is one opposing factor to this plan. We shall never be readers in this busy work-a-day world if we do not take small parts of time for this purpose. Twenty minutes a day is a small amount of time to take away from any program of the day's work. Multiplied by 365 days, it makes 121 hours in a year, or approximately as many hundred pages.

Traveling libraries.—In order that our readers may have what books they desire without expenditure that they do not care for the present to make, we are always glad to urge the use of the Traveling Libraries. The New York State Education Department under the division of Educational Extension offers House Libraries to meet the need for books in rural communities. Ten books may be sent to any household in New York under proper guarantee. Recent fiction is used but rarely. Any good books will be sent so far as possible. If books applied for are not in the

library, time has to be allowed for their purchase unless substitutes will be accepted.

A real estate owner acting as trustee must become personally responsible for the loss or injury beyond reasonable wear. A nominal fee of $1.00 is charged and the amount must be sent in advance for each library of ten books. This pays for transportation both ways and delivery is made to the nearest railway office. By corresponding with the Department, books may be retained for a longer period under certain circumstances.

If any assistance is desired in making up a list, we will be glad to hear from you, or the Department of Education at Albany is ready at all times to render such assistance. It is necessary, however, to know the tastes and requirements of the persons for whom the books are desired.

For fuller information in regard to this subject, address The Education Department, Albany, N. Y.

SOME PRACTICAL HOUSEHOLD AFFAIRS.

Questionable Eggs.—One woman finds eggs much discolored on the inside but having the right appearance on the outside. The eggs were fresh and had no bad odor when broken. The question was referred from the Department of Farmers' Wives' Reading-Course to Professor Rice of the Poultry Department of the College of Agriculture. Professor Rice replied as follows:

"My attention has been called to the unusual experience which you have had in finding discolored eggs which apparently were fresh. I am unable to answer the questions positively with the information at hand. I have never observed precisely that condition. It may have resulted from the prolonged retention of the egg and which, owing to the high normal heat of the hen's body, 105 to 106, caused decomposition. If the egg was retained an unusual length of time it would have caused inflammation, as is frequently the case, when the temperature would have run up to 110 or higher, as we have found to be true by actual test.

"Can you locate the hen that laid the discolored egg?

"Please write me exactly what you are feeding and the nature of the grit which your fowls receive.

"Was there any unwholesome odor about the egg that would indicate a condition of decomposition?"

Canning Receipts.—At the Akron Women's Institute there were several cans of very attractive vegetables displayed in the exhibit of women's work. In the discussion which took place regarding the home canning of vegetables there was much that would be of interest to women

on the farm. Mrs. Charles Blackmore of Akron had used the following recipes with excellent success:

For Canning Peas.—Fill the can as full of peas as possible. Shake them and fill full of cold water. Screw the tops of the cans on tight. Put the cans into a large boiler and allow the water to boil for two hours around the cans. There should be enough water in the boiler to completely cover the cans.

Another plan for canning without steaming is as follows, and several woman in the audience said they had been successful with this method:

For Corn.—Cut the corn from the cob and pack tightly in cans, using a small wooden potato masher to cram the corn into the cans, thus getting all the air out. Use ½ teaspoon of salt for each can. Screw the tops on tight and place in the boiler. This recipe requires boiling for three hours. Others had tried the method of placing the corn into jars with a large amount of salt in the corn, packing it and covering it tight. The corn while quite salty when ready to use on the table is cooked when it loses much of its saltiness and has a very excellent flavor.

Water-supply.—One of our readers has asked an interesting question regarding the water-supply on the farm. This is one that will interest many persons, inasmuch as every farmer has to work out this problem, lacking the public supply of water and a sewer system as is found in the city. The reader says:

"Our house is built on the lowest point on the farm. Our water from a spring some distance from the house is on a level with the floors. How can a drain be satisfactorily arranged? How can the water be brought to the house? We have tried a pump, but it is easier to bring the water by hand than work the pump. Could flowing water be arranged in the kitchen? Would a cess pool be sanitary? These are questions over which I have pondered for four years. Can you give me a satisfactory solution?"

Another member of the Farmers' Wives Course says:

"I am contemplating a sewer system, getting water from a mountain about 300 feet elevation. What pressure can I get from one and one-half inch pipe? What kind of pipe would you advise using, lead or iron?"

These questions were submitted to Prof. Ogden, College of Civil Engineering, Cornell University, who replied as follows:

"It is very difficult to solve a topographical problem without a map or levels, or without having seen the ground and the topographical conditions. It does not seem possible to me that the house can 'be built on the lowest point of the farm' because if it were so there would be a pond of water accumulated there. There must be a depression running out from this low place in some direction, although perhaps on to another person's land, but, even so, giving drainage to the farm. With the water

coming from a spring at some distance, a cesspool would be perfectly sanitary if the soil be suitable, that is porous enough to carry off the seepage. The only danger would be the possibility of contaminating the spring, apparently not likely. I cannot reconcile the two statements that the house is at the lowest point with the presence of the spring some distance away, on a level with the floors. The ground is either very flat, not likely with a spring, or else the level question is not accurate. One cannot say how a pump would act because your questioner does not give the distance from the house to the spring. I am inclined to think that the pump in use must be a worn-out pump if it is more work to pump than to carry. If the spring is at a distance of over 500 feet, it would probably be cheaper and easier to run a pipe from the spring into the cellar of the house into a cistern of brick or concrete or even of wood, ana pump with an ordinary pitcher pump vertically from this cistern into the kitchen sink. But if your questioner has been trying to pump through a long line of pipe with the ordinary pitcher pump, it is not surprising that she found it hard work. In such a case, the friction in the pipe would increase the resistance so that the pump might not work at all. A better make of pump might solve the difficulty, and I will be glad to make suggestions of that kind if you so desire, when I know more of the conditions. As to the kind of pipe to use in bringing the water to the house, I would suggest galvanized iron pipe. If the water runs into a cistern, one-half inch pipe would be large enough, but if a pump is to work directly on the pipe I should use three-fourth inch as the smallest size, and one inch would be better."

WITH THE FARMERS' WIVES' CLUBS.

"In reply to your letter, we should like to report our Farmers' Wives' Reading Club in connection with Yorktown Grange No. 862. Our meetings are held during the Grange meetings and it is our aim to make the Grange more interesting and helpful. We hope this winter to do the work as laid out in the program you sent and feel that a good many more of our Grange members will take it up then. As yet only about one quarter of our sisters have become interested enough to join the club. Do we use the same programs next fall and the same bulletins? We do not hold any meeting in the Grange from the middle of June till about the first of September, so our club will have to rest over too. If there is any reading matter to be sent out during the summer months, I think all the members of our club would be glad to receive it. We thank you very much for your kind offer of help and doubtless you will hear from us often, as it is an entirely new undertaking to all of us.

"YORKTOWN HEIGHTS, NEW YORK. MRS. CHARLES A. BUSHELL."

"The picture below shows the members of the Cornell Domestic Club of Chuckery (near Utica), N. Y. It was taken at the reorganization of the Club for the second year. Their discussion for this meeting has been on the Rural School and a committee was formed to visit the school to see what was needed. The club was organized a year ago in September having two meetings a month until March with an average attendance of

A Farmers' Wives' Reading-Club at Chuckery, N. Y.

over three quarters of its members. There were also two extra meetings during the summer, the latter being a well patronized Sweet Pea contest. The club comes to order at half past two for an hour of work, then adjourns for a social hour with a cup of tea and cake. It is the aim to have things simple that the hostess can also enjoy her friends. This year there is a larger attendance and the club hopes to write out and send to Cornell its discussion papers.

"Miss A. M. WHITE, *Leader.*"

"When we closed our meetings last spring it was decided to hold them again the coming winter. We have about decided to wait till after Christmas before we have any meetings. We think most of the old members will continue the reading and perhaps a few new ones. We had 18 in the club last year; we may have 20 this year. We shall be pleased to entertain you or any of your representatives at any of our meetings. We had very pleasant and profitable meetings last year. We have had two social gatherings this summer, one in strawberry and one in grape time.

"Last winter we met at the different homes, and had our dinner at 1 P. M., the hostess providing the dinner, limited to eight articles. Our literary program began at two o'clock and lasted two hours or more. We usually went home at 5 P. M., as all were farmers and had chores to do. The bulletins were discussed, we had a question box, recitations and music at each meeting. We think the bulletins excellent and we can learn much from them. Last winter was a very favorable one, we did not have to give up a meeting on account of bad weather.

"NEWARK, N. Y. CHAS. H. GARDNER, *President.*"

SUPPLEMENT TO

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MARTHA VAN RENSSELAER, *Supervisor.*

SERIES V. ITHACA, N. Y., DECEMBER, 1906. No. 22

SUPPLEMENTARY DISCUSSION-PAPER.

To be returned to Reading-Course for Farmers' Wives, Cornell University, Ithaca, N. Y.

This Discussion-paper, accompanying this Bulletin, may be returned with answers to the questions and with any suggestions and questions of your own.

1. What can be done in long winter evenings on the farm? Reading will be the first suggestion. Discuss not only that but other means of making the home attractive and the evenings profitable and enjoyable.

2. What book have you read in December or recently? Did the book keep up a constant interest? On what did the interest depend? Is it one soon to be forgotten or is it one which will enter into one's life experiences? Do you know what led the author to write the book? Can you read the character of the author in the book? Select a picture. Tell what the picture says to you.

3. What suggestion can you make for actually simplifying household work?

Name....................................

Address...............................

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SERIES V. ITHACA, N. Y., JANUARY, 1907. No. 23

A SUPPLEMENT TO BULLETINS Nos. 2 AND 3.

The Farmers' Wives' Reading-Course is deemed to be practically complete with the four series covering bulletins one to twenty, although the work of women in homes will always admit of further study in the improving of conditions of work, the lessening of labor and the bettering of home products.

Series V aims to make the twenty bulletins workable by printing suggestions and correspondence concerning them, by instructing correspondents and clubs as to best methods of procedure, and by serving as a means of keeping acquainted with the members of the Reading-Course who have taken the four years' Course. The readers register in one of the former Courses or Series (I to IV). The present series is not for the purpose of securing new readers.

The present Bulletin (No. 23) is a supplement to Bulletin No. 2 on "Decoration in the Farm Home," and Bulletin No. 3 on "Practical Housekeeping."

I. SUPPLEMENT TO BULLETIN NO. 2 ON "DECORATION IN THE FARM HOME."

The meaning of pictures is a subject to which very little careful attention is given. Most persons seem to regard a picture as a picture; but there are "points" in a good picture, as much as there are in an animal or a cheese. It is for the purpose of illustrating some of these points, in order to suggest the significance that lies in pictures, that the following article and the one of last month are written.

BREWING MISCHIEF: UNITY IN VARIETY.

By CHARLES DEGARMO.

What particular piece of mischief the little maid is brewing, it would be hard to tell, but it is easy to see that there is mischief in the air. The face and pose of the gypsy maid are surcharged with the growing determination to do something that will be a mixture of audacity and

Brewing Mischief.

frolic; for how can she help it, with all the stimulating influences about her.

First, there is a cauldron on its tripod. What does it contain? Surely not potatoes and cabbage, or pork and beans, but something akin to the contents of the witches' cauldron in Macbeth, yet not dreadful like that. Each may surmise for himself what is in it that brews the spirit of mischief for a maid so tender. Perhaps among the rest the impertinent caw of a crow, the saucy whisk of a squirrel's tail, and maybe just a hair from the tip of the tail of Old Nick himself. Whatever is in the pot, it is plain that it is mischief that is brewing; for who feeds the fire? A lot of brownie imps, as innocently audacious as the little mistress they serve. They bring the brush to feed the fire, and blow the flame that boils the brew that helps the maid to make the mischief.

And on the other side, what have we? A witchlet's broom and conical hat; under which crouches a kitten bewitched, ready for a wild charge upon granddaddy-long-legs in front. Finally, in the rear rises the moon ready to give full backing to all mad freaks of the little lunatics in front.

Everything contributes to the central idea, the unity of the whole—the fertile mind of childhood, the freedom generated by the outdoor gypsy life, the mischief-brewing pot, the mischievous implets that keep it boiling, the symbolic hat and broom, the frolicsome kitten, and then old Luna herself, who is renowned for infusing the minds of maids, both young and full-grown, with a touch of madcap spirits.

So important is this idea of unity in variety, or to put it the other way, variety in unity, that many have considered the resulting harmony of the whole to be the chief characteristic of beauty. Yet we shall have to say that there is something else, for what would harmony amount to if it expressed nothing? Art always has a meaning, and this meaning is of and for the mind. Fundamentally, as Ruskin and many others claim, a work of art has worth and meaning, primarily for the significance of the ideas that it expresses, and only secondarily for the excellence of their expression in form and color.

This picture is certainly good art. It is good, because the idea revealed is an interesting aspect of the mental life of childhood, and because it is an usually successful example of the unity possible among a number of contributing details.

A successful costume exhibits the same elements of unity in variety. For household labor, the neat print, the becoming apron, the natty cap to protect the head, together set off and adorn a comely face and cheerful expression. A hat for holiday outing, will match the color and style of the outer garments, and will crown with grace and dignity the whole costume.

Even if not the greatest thing in art, unity and variety of parts are at all events necessary attributes.

II. SUPPLEMENT TO BULLETIN NO. 3 ON "PRACTICAL HOUSEKEEPING."

In connection with practical housekeeping, the keeping of fires, the cost of fuel and the proper cooking of food afford much material for thought. The kitchen fire has seen a series of improvements since the time of the great chimneys in the back of which hung the "lug pole" of green wood from which were suspended the pot hooks and kettles, often the precious possessions of the family.

In strong contrast to the utensils of various sizes, shapes and materials now covering a stove, were the heavy iron or brass kettles few in number which hung above the crackling fire. Here the vegetables were often boiled in one pot and the chimney place was so large that an entire beef might be roasted at one time.

> "A fireplace filled the room one side
> With half a cord of wood in—
> There warn't no stoves (tell comfort died)
> To bake ye to a puddin."—*Lowell.*

Then came the bake oven, the stoves, the ranges, the gas plates, the electric heaters, and the Aladdin ovens.

"The Hay Box."

In the German army for some years the "Hay Box" has been used to advantage, and it is recommended to housewives as a means of saving fuel and securing good results in cooking cereals, chicken, macaroni, or anything requiring long, slow cooking or steaming.

It may be only a close, wooden box with good cover lined with hay, asbestos, cork or other non-conducting material. The principle is to retain the heat which is generated by use of any ordinary coal gas or oil fire. Nests should be made in the hay in which will fit closely the pots containing the articles to be cooked. The food is to be brought to the boiling point in utensils which may be very closely covered and placed in the nests prepared in the hay or other non-conducting material with which the box is lined. The box must be closed

immediately in order not to allow the heat to escape. The outside cool air cannot reach the utensils nor the inside hot air escape. The food continues to cook evenly and thoroughly. About twice as much time is required as in cooking over the flame. There is little evaporation. Consequently, care must be taken not to use too much water in preparation.

Many articles of food are better for long, slow cooking and as no fire nor attention is needed it proves an economical means of preparing food for the table.

While a very desirable cooker is on the market, many make their own so-called "hay-boxes."

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MARTHA VAN RENSSELAER, *Supervisor.*

SERIES V. ITHACA, N. Y., FEBRUARY, 1907. No. 24

SUPPLEMENT TO BULLETIN No. 2.

Farmers' Wives' Bulletin No. 2, Series 1, "Decoration in the Farm Home," besides suggesting principles in home decoration, emphasizes the desirability of simplicity. We gather too much about us; it collects in the cupboards and on the shelves; it has to be dusted; it occupies a place where space would be more expressive; it has become meaningless in our lives; it seems too good to throw away but it is really doing more harm than good; it troubles us as any other clutter will. Our tastes have changed since certain ornamentation was placed in our parlors. We may have thought it a desirable acquisition at the time and no doubt it did us good then. If it does not do us good now, it has served its usefulness.

Beauty is in the mind of the observer and we have a right to change our minds. Our larger fault is in clinging to old sentiments. We need to throw away many of them and to get new ones. Our lives need this rejuvenation.

The question arises as to what to do with the mats, the vases, the mottoes, the picture cards, the poorly framed pictures, the lambrequins and what-nots. A good motto is to keep that which is uplifting as long as it remains so. Then if it is likely to be helpful in the life of some other person, it may be passed on. If it is not calculated to serve that use, it should help to make a bonfire.

We may not understand the principles of art, and yet be possessed of artistic temperament or capable of artistic training. We may hold the erroneous idea that to be artistic one must express it by painting a picture. Every one may express an artistic temperament either in dress, in house furnishings, or even in the arrangement of flowers in a vase. This is the adaptation of the artistic sense to life itself, which is the best aim in education.

One simple and effective standard is nature itself. A pot of flowers, a vase of flowers, effectively placed is worth all of the questionable ornament which can be supplied. Life has zest just in the contemplation of these simple forms of art.

The following little anecdote told recently carries a great meaning:

"Mary, come out, the violets are in bloom."

"No, I cannot, I am housecleaning."

"Dirt will keep, but violets won't."

She went.

A PIECE OF GREEK SCULPTURE.

A STUDY IN GRACEFULNESS—BY CHARLES DEGARMO.

To illustrate some of the principles of art and good taste as expressed in pictures, a piece of statuary is now described. It is of no consequence that any home should contain this particular picture, but the discussion of it will teach a lesson that can be applied to other pictures.

This statue is called Diana of Gabii in Latium, where it was found. It is preserved in the Louvre at Paris.

What makes this figure graceful? It is slender and well poised. The arms and hands are performing their wonted functions in a manner easy and natural. All the fingers of the left hand are employed in holding the lower end of the mantle, while only the thumb and first two fingers of the right hand are used in grasping the brooch at the other. The remaining fingers project in charming curves, ready to serve but not now serving. The right foot supports the body, while the left is so placed as to suggest either the easy preservation of equilibrium or a preparation for advance. The head is delicately poised as if awaiting the sound of the horn that shall announce the coming chase. For Diana is the goddess of the hunt, the sister of Apollo of the flaming arrows. Her garments hang in becoming folds, revealing here and there the well-rounded form, and adding to the charm of its smooth curves by the long sweeping creases and folds of the drapery. Gracefulness is the result of the perfect equipoise of mind and body, when the mind is alert and forceful, yet not perturbed or excited. The soul then fills the body with self-controlling energy, while head, arms, hands, trunk and lower limbs fulfill with ease and perfection every function assigned them by the ruling mind.

A part of the gracefulness of this statue is found in the fact that a moment is chosen when the purpose of the mind is suggested rather than fulfilled. For the mantle is not yet fastened, though we are sure it soon will be; Diana is not walking, but she is ready to walk; she is not speaking but may at any instant break the silence. In short, one has the feeling that the whole body is pervaded and controlled by the mind and is ready at each instant to do its bidding.

It was Lessing who pointed out that the nature of solid material compels the artist to suggest action rather than attempt to portray it.

Diana of Gabii.

An example of an unsuccessful effort to make a statue seem to speak is that of Marshal Ney, erected on the spot where he was executed in Paris. To indicate that the General is shouting to his troops behind, the sculptor has represented him with wide open mouth. When last seen by the writer, the sparrows were nesting in it. A petrified smile soon degenerates into a grin; hence though even a radiant smile may be suggested in a statue it must never be attempted. So likewise a sweeping action must not be arrested when half completed. The sword of Damocles while still suspended by the hair is awe inspiring, but pictured as half way from the broken thread to the head of the sleeper, it would be absurd—a falling body that does not fall.

The beauty and grace of the Diana grow upon one as contemplation continues. See the shell-like ear, the charming waves of the hair with its slender fillet, the beauty of the shapely head and expressive face, the graceful curves of arm and neck and bosom, the satisfying folds and loops of the costume, nothing short of marvelous when one considers that these effects are produced with hardly a seam, with no other pattern than the human form itself, and from the two pieces of rectangular cloth, which for the most part are innocent of needle or shears. Probably Diana's thoughts are as simple as her garments. Yet

there is a serenity that is not vacuity, a repose that is not indolence, a vitality that is not vehemence—in short, a harmonious balance between the mind that commands and the body and habiliments that serve, which taken together make up what we call the graceful, the very soul of Greek statuary.

The graceful still has a function to play in life, for it means economy of effort and it conduces to the joy of living. Awkwardness in motion or behavior, ungainliness of posture or dress, proclaim unsymmetrical development of body or defect of mind. The satisfaction we feel in worthy character is always enhanced when we can add the delight that arises from grace of motion, form, feature and garment, and from those subtler graces of mind and heart that now adorn the few, but should be the happy procession of the many.

COMMENTS FROM MEMBERS OF THE READING-COURSE.

In the Discussion-paper of Bulletin No. 2 referred to above, readers were requested to comment on the attitude of the woman who said, "There, I embroidered a lovely silk pillow, and John has gone and laid his head on it!"

In the comments which have been made John in the main gets the best of it. The pillow is not necessarily sacrificed by remaining as a rest to his head but he is made quite as comfortable on something else.

We give a few of the answers which are suggestive of the general attitude toward John and the pillow.

"For what is a pillow if not for tired John's head? If that is the object of a pillow, embroidered silk is not a suitable covering.

"How many good magazines might have been shared with John while his wife was at work on the pillow?

"How much will it cost for spectacles to repair the damage to her eyesight?"

"There are a good many such women and one feels so uncomfortable in a room where things of that nature were made to be 'looked at' not used. They certainly should be placed in a glass case and a few soft-downy pillows with wash covers for John to lay his head on put in the cozy corner."

"I do not think the woman ever said that for, if she felt so particular about her things, John would rather have gone to the barn and rested on the hay mow than have come in the house and have his wife grumble because he was using her silk pillow. My husband puts his head where he pleases, but we have no silk pillows. Ours can be washed when they are soiled."

" In the first place if the silk pillow is too nice to be used, it should not be placed where John can use it. Secondly, if silk pillows are used they might be covered with a tidy which when soiled could easily be washed, and above all, why should we have them or anything about the house too nice to be used? Everything will collect dust and get soiled in time (if not in use) so I say don't have anything too nice for John or anyone else to use, for life is short and death is sure."

" If John had pulled his pocket-book to pay for that pillow at the store he would know its worth and not lay his head on it. Can he not see that she has saved the money by her labor and made the room look more cozy and attractive by it? We have carpets and rugs but not to wipe the feet on, tidies but not to dust their old coats on and pretty pillows, but not to sleep on. But I believe in having a couch somewhere with pillows having washable covers—and rockers also that John can rest and take his comfort in when tired."

" I think the woman who has such things that are too good for her husband if such could be the case, ought to live in a room where they are, all by herself, that they would not be harmed. I do not think it wise to always use your best things too common and yet if we at home have not earned the enjoyment of them ourselves by our hard work, who has?'

" Provide plenty of pillows that will wash and at the same time be neat and tasty.

" And for the lady who likes silk pillows have them in the parlor.

" Farmers' wives need not go without all the pretty things because they are on a farm."

" It looks as if she thought more of the pillow than she did of her husband's comfort and feelings. I don't believe in having things too good for your husband and children to use."

CORNELL

Reading-Course for Farmers' Wives

PUBLISHED BY THE NEW YORK STATE COLLEGE OF AGRICULTURE, AT CORNELL UNIVERSITY, FROM NOVEMBER TO MARCH AND ENTERED AT ITHACA AS SECOND-CLASS MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, Director.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES V. ITHACA, N. Y., MARCH, 1907. No. 25.

SUPPLEMENT TO BULLETINS Nos. 2 AND 3.

In the three previous bulletins, we have discussed some of the principles of art as expressed in certain formal pictures. We have endeavored to discover why certain pictures are good, and, by this means, to arrive at some standard for the judging of pictures. Every picture is either good or bad, whatever the subject; it remains for us to determine why it is good or bad.

The reader must never think that all excellence in pictures lies in the formal and historical pieces alone, although every residence may well have a few such pieces. The farmer and his wife, should be able to see the picture in the landscape and in the customary objects and operations of the farm. Some of the things that we have learned in the last three bulletins, we may now apply to a photograph taken in New York State.

THE BEECHES—A STUDY IN UNITY.

BY W. C. BAKER.

Pleasure in the contemplation of pictures grows with the increase of knowledge of their construction, that is, of their composition. The artist does not often represent in his picture exactly what is before him in nature. He must almost invariably eliminate and rearrange. He selects only those elements necessary to express his idea and arranges these best to suit his purpose. This is "composition."

"Art is not nature or the imitation of nature. Art is expression. The purpose of the artist is not to mirror nature nor yet to give moral instruction, but to stir the emotions. The merit of a picture is determined not so much by its likeness or unlikeness to nature as by what it suggests or awakens in the observer. If the picture expresses the feelings the artist experienced in the contemplation of the scene, its mission is fulfilled. If in gazing at a picture one is stirred as was the photographer when moved to record that scene, in so far is that picture a work of art. It

The Beeches.

is not very difficult, therefore, to understand why this picture of "The Beeches" was made.

The elements that go to make up a work of art may be many or few, but all should contribute to the expression of one idea. All details should be subordinated to the principal subject. There should be one picture and one thought. Of this principle of unity or "oneness," "The Beeches" is a good illustration. There is but one centre of interest.

This centering of the interest is accomplished by various means. There are other objects in the picture, but it will be observed that the focus is sharpest on the trunks; there the details are most definite. The eye travels about in the scene from the grass to the scrub willows, to the leafy canopy overhead, but always, on account of the lack of definition in these, is forced back to where it can see most clearly. The eye is not only thus *forced* to the center of interest but is also *led* to that point by the main lines of the composition,—the converging limbs and line of the hillside. And finally as the attention is caught and held at the point of greatest contrast we have here still another means of gaining the attention. The fact that there are two trees instead of one might be noted. Imagine the farther trunk eliminated and there would be an appreciable loss. It is more or less of an echo of the principal subject and so adds emphasis and also serves as a foil for the shadow side of the latter.

And now that the attention has been centered on the subject of the picture, in what does its interest consist? Why do these trees make such a good subject for pictorial representation? It is because they are so full of character that they show so much individuality; they have a story to tell. How different from the trees in forest communities where, like men in the crowded city, all come to look quite alike! For most of their lives these have grown in the open, on this hillside, and plainly show the struggle with the elements thus far survived. Not the least interest in a subject of this kind is that of association, of reminiscences awakened—memories of the Golden Age when the call of the woods was easily answered, when spring hepatica were loveliest, summer beech leaf silkiest, autumn beech-nuts sweetest, and life's enjoyment fullest.

THE FLOWER-GARDEN—REMINDER OF BULLETIN NO. 5.

In the Farmers' Wives' Reading-Course of the present year there have been pictures presented with suggestions for study during the winter months. Springtime is almost here and we naturally turn our attention to pictures out-of-doors. The awaking of spring causes us to ask, "Shall we have a flower-garden?" With the rush of spring work, we long for time to stir the soil and to plant the seed. The making of

a flower-garden should hardly be considered as a duty. To afford most enjoyment it must not be perfunctory. Its main object is aesthetic, not useful, only as the beautiful has a use.

To make a garden only because other people have one is of little merit. The reason for having a garden is because one cannot get along without things growing and budding and blossoming. If one would make the flower-garden a valuable accessory to the home, it may be necessary to begin with one's inward feelings. One person believes in the personality of books and loves even to handle them. For him a library is necessary. Another finds great happiness in music, and a piano is desired. There are still others for whom the pet animal has greatest fascination, and there are those for whom plants will readily bloom and thrive. Human interest may be aroused by means of flowers and plants; and lack of time, lack of knowledge, or lack of space does not prove a serious barrier to the window-garden or the garden out-of-doors.

The suggestion was once made in the Farmers' Wives' Reading-Course that a flower at each place at the breakfast table was a happy beginning of the day. A reply came from a woman already overcome with household duties: "Do you realize what it means in the busy life of the farmer's wife to go out every morning to pick fresh flowers, saying nothing of the time is requires to cultivate them?" If this were a necessary article of food, it might be well to urge one to be faithful in performance, but unless she enjoys picking the flowers with the morning dew still on them and has pride in the decoration it gives to the dining-table and in the pleasure it affords others, it is a wearisome task.

One's own flower-garden develops a happy sense of ownership that is recognized by children as well as by adults. It is gratifying to see it develop into a blaze of beauty as if the result of one's own workmanship. The child never gets away from this influence.

It is not necessary to have a showy garden in the front yard. Flowers are best in quiet and modest surroundings. They suggest repose. They are for comfort, much as are one's books or close friends. They add cheerfulness to that part of the home or grounds where one stays the most. They are useful also to hide the woodshed, the clothes-yard and the chicken-coop.

One has only to mention the names of certain flowers to set going a whole train of pleasant recollections and to cause one to want to start a garden at once. The garden of "herbs" should not be neglected. The odors almost seem present with us even on a March day,—sage, sweet marjoram, mint, tansy, thyme, sweet basil, lavender, old-man, catnip, dill, fennel, caraway, camomile and rosemary.

This note is to call attention again to Bulletin No. 5 of the Farmers' Wives' Reading-Course on the flower-garden, for it is now time to prepare for the year's garden crops. It will also call attention to Bulletin No. 4 on the kitchen-garden.

SPECIAL NOTE TO THE READER.

We desire now to renew and correct the mailing lists of the Farmers' Wives' Reading-Course. Persons who desire to retain their names on our lists should write us to this effect. A postal card notification will be sufficient. **Should we not hear from you, we shall conclude that you wish to have your name dropped.** *We do not desire to drop any person who wishes to continue to read the series as now published.*

Should you have any suggestions to make, we shall be glad to have them. Questions concerning the work of women in the home are welcomed. We have always found much of interest in the information gathered from the answering of the discussion-papers. We urge our members to return these papers with answers to the printed questions. The excuse is frequently offered by members that they cannot give any helpful suggestions; and they refrain from writing. Often ideas to one are new to others; and by correspondence we are enabled to know our members better. It gives life and inspiration to the work. May we not hear from you frequently?

MARTHA VANRENSSELAER,
Supervisor.

Home Nature-Study Course

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HOME NATURE-STUDY COURSE.

TEACHERS' LEAFLET.

Based on the fall work for first and second year pupils as outlined in the Syllabus of Nature-Study and Agriculture, by the New York State Education Department.

The members of the Nature-Study Bureau of the State College of Agriculture at Cornell University, think that they can be of most use to the teachers of the State by giving them aid in working out the lessons of the Syllabus of Nature-Study and Agriculture, which has been issued

Photo. by C. R. Crosby.

A Natural Seed Package.

by the State Education Department. The Syllabus gives a wide range of topics, so that teachers may follow their own inclinations in selecting subject-matter. We hope that the outlines as given in this leaflet will be regarded merely as suggestions meant to be helpful, and by no means as the final or only way of presenting these topics.

This leaflet is meant for the exclusive use of teachers, and should not be given to the pupils. There is too much information given for lessons for children; it is given for the purpose of assisting teachers so that they may get the pupils to observe for themselves. The matter suggested with each lesson is often more than can be comprehended by the children of

the first and second years, but teachers should certainly know more about a subject than they are called on to teach. As a matter of fact these lessons are fitted for almost any grade; they are not supposed to follow each other, day after day, but should be selected according to the material on hand.

As the number of leaflets issued is necessarily limited, the editor asks that the teachers who wish to have the leaflets for the year will communicate with her every month. These communications may be either of the following:

First, writing out in full the subject-matter of any five of the following lessons, supplementing the information given by personal observations. Second, giving the experience of the teacher in presenting five of the lessons to the pupils of any grade.

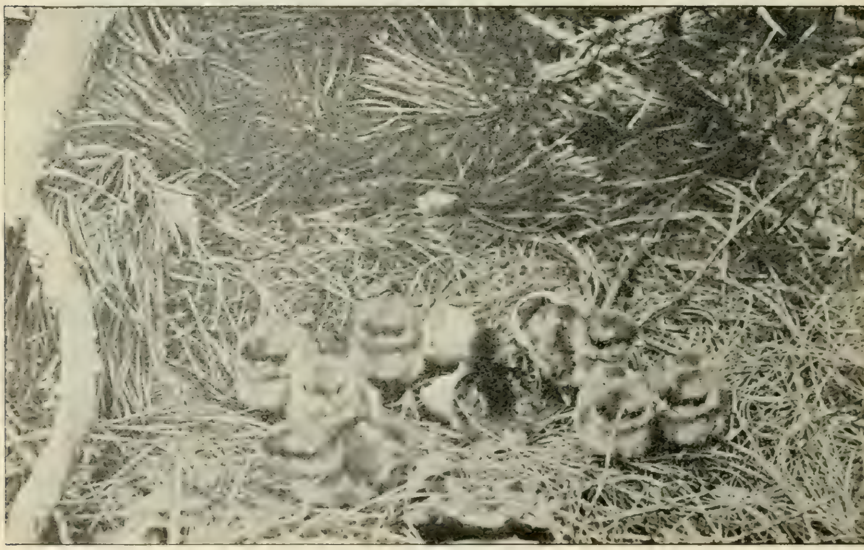


Photo. by George Fishe, Jr.

A Brood of Partridge Chicks.

BEGINNING BIRD STUDY.

The object of the study of any bird by any person is to ascertain what the bird does. In order to accomplish this, it is necessary to know what the bird is,—what it is being simply the step that leads to what it does. What a bird does includes all its life habits, and to know these is the object of the careful ornithologist, and is likewise the object of the merest beginner. And just as truly it should be the object of the youngest child, for the child naturally being interested in what the bird does, learns in this way what the bird is.

Our domestic fowls are well adapted for the beginner in bird study because they give opportunity for continued observation; and if the study is rightly begun, the child will be able to understand better all bird life because of his understanding of the habits of these common birds.

Preliminary Work.—There are two good ways of presenting this topic: First, if the pupils live in the country where they have chickens at home, the whole series of lessons may be best done through interesting talks on the part of the teacher, letting the children make their observations at home and report the result either in oral or written lessons. Second, if the pupils are not familiar with fowls, a hen and a chick if possible should be kept in a cage in the schoolroom for a few days, and a duck or gosling should be brought in one day for observation. The crates in which fowls are sent to market make very good cages. One of the teachers of the Elmira schools introduced into the basement of the schoolhouse a hen which there hatched her brood of chicks, much to the children's delight and edification. After the pupils have become thoroughly interested in the hen or chick and are familiar with her ways and have fed her and watched her, and have for her the sense of ownership, the following lessons may be given in an informal manner, as if these talks had naturally suggested themselves through watching the hen.

Purpose of lessons.—(a) To induce the child to make continued and sympathetic observations on the habits of the birds. (b) To cause him involuntarily to compare these birds with other birds, and to understand as far as possible the reasons for the differences. (c) To set him to thinking for himself why the shape of the body, wings, head, beak, feet, legs, and feathers are adapted to assist the bird in getting its living.

THE BIRD'S CLOTHING.

We naturally begin with the bird's covering because the wearing of feathers offers the most striking character for distinguishing birds from other creatures; and it is through the use of feathers that birds are enabled to fly, which is the first thing the young child notices about birds.

There are four chief uses of feathers which the child in the primary grades can understand: First, Warmth. Second, Protection from rain and snow. Third, Uses in flight. Fourth, Ornament.

LESSON I.

FEATHERS PROVIDE WARMTH AND PROTECTION AGAINST WIND, RAIN AND SNOW.

Purpose.—(a) To teach the pupil that there are several types of feathers, each absolutely necessary to the bird in order that it may withstand the vicissitudes of climate and weather. (b) The care of the plumage by the bird.

Protection.—The down next to the bird's body provides warmth, and may be compared to the under flannels which we wear, while the smooth, outer feathers may be compared to a rain coat ("Story of the Birds," p. 29). A breast feather shows both of these uses; it is fluffy at the base which is near to the body of the bird, and smoothly webbed at the tip where it overlaps another feather like shingles on a roof, thus helping to shed rain. Note how smoothly the feathers overlap on breast and back. Note how a hen looks after being out in a rain, note how the outer parts of the feathers are arranged to shed the water. The pupils should see what parts of the body are most covered with down, and should note that these are the parts that would be exposed to the cold (Jenkins and Kellogg, p. 141).

The care given to its plumage by the bird.—The following observations should be made on the way fowls oil their feathers: (a) The position of the gland; this may be seen on the plucked fowls in the market. (b) How the fowl extracts the oil by squeezing the gland with its beak. (c) How the oil is applied to the back and breast. (d) Induce the pupil to note if there are any feathers on the body not oiled. (e) Is it true that hens oil their feathers before storms?

Another lesson should be given on the sun bath and the dust bath, these two being often combined. The points for observation should be: (a) How the fowl lifts the feathers so that the sun may reach the body. (b) How she turns from side to side. (c) When ducks take sun baths they turn their feet bottomside up, which is a good lesson on the value of sunshine as a destroyer of microbes. (d) What sort of soil the fowl chooses for the dust bath. (e) How does it manage to get the dust thoroughly into the feathers? This study should be followed by a talk from the teacher as to the uses of the dust and the sun in freeing the fowls from the insect parasites. These are among the greatest pests to the chicken raiser, and it would be well to explain to the pupils how cleanliness and the white-washing of the walls and perches of chicken houses are necessary to keep the birds healthy and free from such pests.

LESSON II.

THE USE OF FEATHERS IN FLIGHT.

Purpose.—(a) To teach that the bird flies by pressing down upon the air with its wings. (b) To show the bird's most obvious adaptations for flying. (c) To suggest the reason a bird needs to fly. (d) To develop in the pupils the habit of observing the flight of birds.

The bird flies by lifting itself through pressing down upon the air with its wings. There are several experiments which are needed to get

the child to understand this. It is difficult for children to conceive that the air is really anything because they cannot see it, so the first experiment should be to show that the air is something we can push against or that pushes against us. Strike the air with a fan and we feel there is something which the fan pushes; we feel the wind when it is blowing and it is very difficult for us to walk against a hard wind. If we hold an open umbrella in the hand while we jump from a step we feel buoyed up because the umbrella presses down upon the air. The bird presses down upon the air with the wings, just as the open umbrella does. The bird flies by pressing down upon the air with its wings just as a boy jumps high by pressing down with his hands on his vaulting pole (" The Bird Book," Eckstorm, pp. 75-92; " Story of the Birds," Baskett, pp. 171-176; " Bird Life," Chapman, pp. 18-19 Cornell Nature-Study Leaflet, April-May, 1905).

This should be followed by a lesson on the bird's wing, and the outspread wing of a fowl is perhaps the best material for this lesson. It should be shown: (a) That the wings open and close at the will of the bird. (b) That the feathers open and shut on each other like a fan. (c) When the wing is open the wing quills overlap, so that the air cannot pass through them. (d) When the wing is open it is curved so that it is more efficient; for the same reason that an umbrella presses harder against the atmosphere when it is open than when it is broken by the wind and turned wrong side out.

Observations should be made on the use of the tail in flight. The hen spreads her tail like a fan when she flies to the top of the fence. The robin spreads its tail also like a fan. The fact that the tail is used as a rudder to guide the bird in flight as well as to give more surface for pressing down upon the air is hard for the younger pupils to understand, and perhaps can be best taught by watching the erratic unbalanced flight of young birds whose tail-feathers are not yet grown.

A discussion should follow as to why a hen cannot fly as far or as rapidly as a robin. Attention should be called to the size of the wings of the two birds as compared with the size of the body. Also the fact should be remembered that the hen does not need to fly like a robin, as the hen gets her food on the ground, and she needs only now and then to fly over the fence to get into the garden, or to escape when the dog chases her, or to fly up to her perch.

LESSON III.

FEATHERS IN RELATION TO ORNAMENT

Purpose.—To cause the pupils to notice that the color of feathers and often their shapes contribute to make the bird more beautiful.

The ornamental color and form in feathers as the result of sexual selection is a subject that belongs rather to the realm of science than to nature-study. But leaving aside as the question of how the beauty in feathers came about, the study of them as attractive objects is something that even the youngest pupil can comprehend; and, with this knowledge should also come the fact that birds with beautiful feathers know that they are attractively dressed ("Bird Life," Chapman, pp. 42-47; "The Bird Book," Eckstorm, pp. 143-145; "The Story of the Birds," pp. 44-52). To instil this idea I know of no object lesson so good as that presented by the turkey gobbler; his strut and entire appearance is one of excessive vanity. Let the pupils see the exquisite irridescence of his feathers as he shifts his outspread tail so that the sunshine may strike across it, and show it off to the best advantage. Let them also see how he throws out his breast, and how he regards his blue and red wattles. The youngest child will realize that this fowl is showing off his plumage.

The rooster may be the next lesson in the study of beautiful colors. Attention should be called to the different shapes of the ornamental tail feathers, which curve gracefully and which are not used as a part of the tail rudder in flight. The proud, high-stepping manner of the rooster also shows what he thinks of himself.

The peacock is perhaps the most striking instance of the coloration of male birds. If the pupils cannot see this bird, they can see pictures of it and study the peacock feather. They should note the shape and different colors of the eye spot, the changeable green and blue which surrounds it, the broad circlet of bronze, and the narrow bands of gold and green. Other common instances of beautiful coloring are found in the male oriole and goldfinch.

While the ornamental coloring of feathers is studied, attention should be given to the bright-colored combs and wattles of the barnyard fowls.

LESSON IV.

THE BEAK OF A BIRD IS ADAPTED FOR GETTING THE FOOD OF THE BIRD.

Purpose.—To induce the pupil to observe the different forms and textures of the beaks of birds, and to reason out for himself the uses of beaks.

It is well to begin this lesson with the food of the hen. What do we feed her and where do we put the food? If we do not feed her, what does she live on and where does she find it? Her beak is sharp and horny and especially adapted for picking up seeds and insects. Contrast the shape of the hen's beak with that of the duck, which is broad and fitted for grasping the water weeds and the insects clinging to them.

If a duck be fed by placing its food in a wash basin of water, it will thrust its bill in and then by opening and closing it with great rapidity set up an eddy, which will bring the floating food in the circling current where it may be strained out by the beak and swallowed.

While studying beaks, attention should be paid to the nostrils situated near their base. The sense of smell is not supposed to be very greatly developed in fowls, but the nostrils are there ("The Bird Book," Eckstorm, pp. 99-107; "Bird Life," Chapman, pp. 30-33; "Story of the Birds," pp. 169, 213).

LESSON V.

THE FEET OF BIRDS ARE ADAPTED TO THE NEEDS OF THE BIRD.

Purpose.—To cause the pupil to observe that birds are in form, size and coloring well fitted to assist the bird in getting to its food as well as at it.

Again begin with the foot of the hen, and note how the toes are long, the claws strong and the whole foot covered with horny scales, which afford a thorough protection for the foot, whose chief business is to scratch the earth to lay bare the seeds and insects, which may be hiding there. Study the track and see how many of the toes show, and also learn to number the bird's toes thus.

Note the differences between the foot of the hen and that of the duck. Which of the duck's toes are united by the web? Here should follow a lesson in elementary physics on the resistance of the web foot against the water when used as a paddle as compared with the foot of a hen where the toes are not webbed.

As soon as the pupil comprehends that the duck's foot is a paddle, develop the thought that the food of the duck is in the water, since it is essentially a water bird. The fact that the hen is a land bird and the duck a water bird is shown clearly in the way the two run. The hen is a good runner, especially with the assistance of her wings, but the duck is a very poor runner, as it has to waddle along, moving one side of the body with each step. The reason for this is that the duck's legs are short and that they are set far back and far apart, so as to propel the body through the water like the wheel of a propeller ("Bird Life," Chapman, pp. 27-30; "Bird Book," Eckstorm, pp. 93-98; "Story of the Birds," Baskett, pp. 161-168 and pp. 213-229).

LESSON VI.

THE WAY BIRDS HEAR AND SEE.

Purpose.—To enable the pupil to understand the presence and value to the birds of these special senses.

The ears of fowls are very well developed although hidden beneath the feathers; in some breeds the ear-lobes are noticeable. The pupils should observe their presence and also the fact that the fowls are sensitive to noises.

The eyes of the chicken are at the side of the head and it may see what is happening in the rear as well as in front. The pupils should notice that when she wishes to observe a thing closely, the hen looks at it first with one eye, then turning her head looks at it again with other. They should see that the bird's eye has no eyelids like our own, but has the "film lid," which passes over the eye when the bird sleeps or winks ("Bird Book," Eckstorm, pp. 108-114).

There should follow a lesson on how the different domestic fowls sleep. They have one habit in common: they all place the head beneath the wing; beyond this their habits vary. Chickens and turkeys sleep on roosts with their legs doubled, so that the feathers on the under side of the body cover the feet; geese and ducks sleep on the ground, although, if the editor's memory is not at fault, they take daytime naps standing on one foot with the head beneath the wing. The placing the head beneath the wing and covering the feet with the feathers may have arisen from the necessity of saving the eyes and feet from freezing ("The Story of the Birds," Baskett, "How a Bird Goes to Bed," pp. 154-160).

LESSON VII.

NEST BUILDING AND EGGS.

Purpose.—To teach the differences in the shape and size and coloring of the eggs of the barnyard fowls and places where these eggs are laid.

This must be a lesson of actual observation either at home or at school. Note should be made on the differences of shape, color and size of the eggs of hens, turkeys, ducks and geese, and a discussion should follow of how many eggs each lays in a clutch, how long it takes to lay the clutch and how long each must sit on the eggs before they hatch.

Incidentally there may be a discussion as to how many eggs a hen would be expected to lay during the year, and how much they would be worth in the market ("Bird Life," Chapman, pp. 65-70; "Story of the Birds," pp. 101-115 and 179-180; "Bird Book," Eckstorm, pp. 201-218).

LESSON VIII.

CARE OF THE YOUNG.

Purpose.—(a) To teach how the mother cares for the young. (b) How the young are fitted to help themselves. (c) The habits of the little ones when following the mother.

This is more conveniently a springtime lesson. Compare the chick and duckling just out of the egg with the little robin or sparrow just hatched and get the pupils to understand that the chick and duckling come forth clothed warmly with down and are active on their feet, because they must be ready at once to run about and follow the mother when she takes them to the field or the pond for their food. Make observations on the following points: How the hen protects the chicks when they are resting by brooding them; the note of warning which tells them to hide because a hawk is near; her motherly cluck which calls them after her through the grass; her special call when she gets a dainty bit of food for some of them; the call of the chicken as it follows its mother; the lonesome call of the chick when it has lost its mother; the fact that the hen with young chicks is very cross because she fears her little ones will be hurt; the differences between the food we give the chicks and the old hen; also the differences between the food which we give the chick and the gosling.

LESSON IX.

THE LANGUAGE OF THE CHICKEN YARD.

Purpose.—The pupil cannot begin too early to understand that the notes given by birds mean something to the bird as well as to us.

The notes of the barnyard fowls give a large range of expression of the elemental emotions which the child naturally understands. It would indeed be a stupid child who could not comprehend the displeasure in the hiss of a goose or the happiness in the song of a hen. Of all the domestic fowls the chickens have the widest range of talk. Get the children to observe the following sounds, which they will readily understand: First, the quiet gossip which goes on between hens when they are taking their sun baths; the song of the hen when she is happy; her cackle of triumph when she lays an egg; the different note from the cackle when she is surprised and a little frightened; the short note of warning given by a hen or rooster when a hawk is in sight; the way the sitting hen scolds when disturbed; the squall which indicates fright; the long horrible squawk which indicates that she is in the hand of the enemy. When a hen is curious about anything she looks at it carefully and utters a little

questioning note; when she calls her chicks she clucks. The rooster crows to show his importance and to assure his flock that all is well. When he finds some tid-bit he makes a call which brings all of his hens running to him, though he often thinks better of it and swallows the morsel himself; he also gives a warning note when disturbed.

After the pupils have learned the language of the chicken, let them study how the turkeys and ducks express displeasure, fright, and how they carry on amiable conversation. This will lead to a later study of the call notes and songs of other birds.

LESSON X.

THE ENEMIES OF THE BARNYARD FOWLS.

Purpose.—(a) To acquaint the pupil with the enemies of fowls. (b) To suggest that all animals are subject to attacks by other animals, and that many of the habits and characteristics of animals are related to the need of self-protection.

These are usually weasels, skunks, foxes, crows, hawks and owls. Of these, all except crows and hawks are night prowlers, which steal unawares on the sleeping fowls.

The following list of books will give interesting accounts of these robbers of the roost: "Kindred of the Wild," C. G. D. Roberts, "The Boy and Hushwing," "Little Beasts of Field and Wood," William Everett Cram (weasels, foxes, mink and otter). "Squirrels and Other Fur Bearers," John Burroughs, (skunk, fox, weasel and mink). "American Animals," Stone & Cram. "Wild Life Near Home," Dallas Lore Sharp, "Wood Pussies" (skunks), "Second Crops" (owls). "Wilderness Ways," William J. Long, "Kookooskoos and the Wrong Rat" (owl). "Ways of Woodfolk," Long, "Snowy Visitors."

LESSON XI.

THE DIFFERENT BREEDS OF DOMESTIC FOWLS.

Purpose.—To get the pupils thoroughly interested in the different breeds and be able to tell them apart.

This lesson must depend on the opportunities of the pupils for personal observation. It would prove an excellent topic for a lesson in English to have them describe the differences between a Plymouth Rock and a Black Spanish hen, or between any two different races, covering the following points: (a) size; (b) color; (c) shape of head, comb, wattles; (d) shape of body; (e) plumage and character of markings;

(f) legs, color, covering and size. The Agricultural Fair is the teacher's opportunity to get the children interested in breeds of fowls, their respective appearances, value and beauty.

LESSON XII.

A STUDY OF THE WILD RELATIVES OF OUR DOMESTIC BIRDS.

Purpose.—To direct the pupils to observe the differences between the wild and domestic fowls. The latter have been developed by man.

After the pupils have become familiar with the lives of our common domestic fowls, it will be most interesting to have them know something about our wild fowls. This may have to be more or less a matter of reading, although most boys have opportunities for seeing partridge, quails and wild ducks, and all have opportunity to see the flocks of migrating wild geese.

In comparing the closely related wild fowl with our domestic species, they should see that man in breeding has first, made the body heavier; second, changed the color and the habits by feeding, so that the birds do not need to hunt for their food; third, has lessened their power of flight, as, for instance, in the case of our common ducks, most of the domestic species being hardly able to fly at all, while the wild ducks are very strong flyers.

The following stories are good for reading, although we do not think that the sad and tragic parts should be given to young children; for example, the tragic parts of such a story as Thompson Seton's "Redruff" should be omitted and reserved for the boy when he reaches the hunter stage, and is inspired by a desire to shoot everything he sees.

References: "Redruff," Thompson Seton; "The Ol' Beech Partridge;" "The Wild Duck, Kwaseekho" (The Sheldrake); "Hukweem" (The Loon); "In Quest of Waptonk, the Wild," all by William J. Long.

GRASSHOPPERS AND CRICKETS.

LESSON XIII

SOME INTERESTING PECULIARITIES IN THE APPEARANCE OF THESE INSECTS.

Purpose.—To enable the pupils to understand that the forms of insects are adapted to their needs.

Preliminary Work.—There should be in the sunshiny corner of the schoolroom two cages, one for crickets and one for grasshoppers. This cage should be made by putting in a flower pot, sod of clover or grass as fresh as can be found. Over this is placed a lantern chimney pressed carefully into the sod so that the insects

cannot crawl under it. On top is placed a square of wire netting to prevent the escape of the little prisoners; (see Figure 342 on p. 540 of Cornell Nature-Study Volume). Into one should be put grasshoppers in all stages which may be obtained by sweeping the grass with a net. Into the other place a few crickets, sufficiently different in appearance so that they may be named, and thus stand as individuals to the children. Let the pupils observe these insects at will, and let the teacher show by her own interest that she thinks the contents of these cages are interesting. After the pupils have become familiar with the way these insects eat and act, the lesson suggested will follow, as an explanation of the pupils' observations.

It is a safe rule in nature-study to teach only such anatomical features of the animal as have to do quite obviously with the creature's life. In studying the habits of the grasshoppers and crickets, the following observations will naturally be made on the appearance of the insects: The hind legs are long and muscular, and were so developed for the purpose of enabling the insects to make long, high jumps. If a boy could jump as far according to his size as a grasshopper, he could make a standing jump of fifty yards. Attention should be especially called to the fact that many animals, such as skunks, and many birds, such as meadow larks, hawks and owls live upon grasshoppers. Thus this ability to make long leaps when disturbed often saves the lives of these insects.

Some of the grasshoppers have feelers not more than one-third as long as the body; others have feelers longer than the body. Those with long feelers are more delicate in appearance and are called the meadow grasshoppers. The crickets and katydids also have long feelers. The pupils should see the use made by the insects of these feelers to discover their surroundings.

If the grasshopper's eye be looked at through a strong lens or a compound microscope, it will appear like a piece of honey comb, that is, it is made up of many eyes; in addition to this the grasshopper has three simple eyes one " right in the middle of his forehead," which can be seen with the naked eye; the other two are above near the large eyes. It should be noted that the eyes are placed in the head so that the grasshopper can see in all directions and, therefore, is better able to escape the enemy.

Observation should be made on the way the grasshopper eats. With the naked eye the children can see that it chews the leaf with jaws that work sidewise instead of up and down like ours.

Incidentally and without direct questioning get the pupils to note that there are three parts to the body; first, the head; second, thorax, the part which bears the wings and legs; third, the ringed portion (abdomen). The mother crickets and long-horned grasshoppers have each a sword-like organ at the end of the body, which is used to make holes in the ground or in soft wood, in which she lays her eggs.

In handling the grasshoppers, notice that they have two ways of preserving themselves; first, by jumping; second, by spitting a dark-colored, disagreeable, acrid fluid upon the enemy.

LESSON XIV.

THE GROWTH OF GRASSHOPPERS AND CRICKETS.

Purpose.—To teach that some insects look practically the same from the time they hatch until they are fully grown, and have no quiet stage, as the pupa of the moth or butterfly.

Observations to be made.—The small crickets look like the old crickets and young grasshoppers look like old grasshoppers, except in the young ones the wings are not yet developed, so they could not fly if they wished to. In the very small ones, the wings are little pads; later they show as wings, but they are wrongside up and the wings are outside instead of beneath the wing covers (see "Comstock's Manual," p. 51). This is the place to study the differences between the wing covers and the wings; the wing covers in the adults are hard and stiff and are held rigid in an upright position when the insects fly; the wings are folded like a fan beneath these covers when not in use.

LESSON XV.

HOW THE CRICKETS MAKE MUSIC.

Purpose.—To teach that the songs of insects are for the pleasure of other insects.

Only the father crickets have musical instruments on their wings; this music is not only used to attract to them their sweethearts, but also it is kept up steadily long after the time of marriage just for the joy of it. The children should observe that the mother crickets, which have the long, sword-like organ at the end of the body never make any music. They should also notice the differences in the wing covers between the father and the mother crickets, the wing cover of the father cricket being a membrane stretched over a frame, which may be compared to the body part of a violin or mandolin. They should notice the way the cricket moves his wings when he chirps. After the chirping has been observed the teacher should give a demonstration either from a wing of a cricket under a microscope, or a picture in a book, or a blackboard drawing showing the file and the scraper ("Comstock's Manual," p. 118). In explaining the mechanism of the music compare the file to the strings and the scraper to the pick, and the wing to the body of a mandolin.

Outdoor observations.—As soon as the pupils are interested in this question of insect music they will naturally observe for themselves. Let them find a black cricket musician; note where he lives, how he acts when disturbed, whether he sings most during the day or in the evening, whether there is more cricket music early or late in the season. On the vines and shrubs may be found a slender, white cricket, called the snowy tree cricket; this sings only late in the afternoon and night (see "Ways of the Six-Footed," p. 25).

LESSON XVI.

HOW THE CRICKETS AND GRASSHOPPERS LISTEN TO MUSIC.

Purpose.—To teach that the hearing organs in insects are not in the head, as with us, and not invariably situated alike.

There should be a little talk to bring out the fact that there would be very little use of an insect making music unless others could hear it. Take a short-horned grasshopper and lift its wings to see the disc-shaped ears on the abdomen very close to the thorax where the wings are fastened (see "Comstock's Manual," p. 58, fig. 70). Take a black cricket and looking at it through a lens, note the white spot on the front legs near the elbow; this is the ear (see "Ways of the Six-Footed," p. 24, fig. 12). The ears of the katydid and long-horned grasshopper are placed in the front elbows, like those of the cricket (see "Comstock's Manual," p. 112, fig. 125).

THE POTATO BEETLE.

LESSON XVII.

Preliminary Work.—The study of the potato beetle naturally follows and belongs to gardening. The larva should be brought into the schoolroom and placed in a breeding cage, similar to that made for the crickets except, of course, its food must be a potato vine. Other plants may be put in the cage to prove that these insects will only touch the potato. Note how they eat and how many leaves one larva eats during its life time, and how the larvæ go down to the earth to change to pupæ; in fact, all their habits are interesting, because we must know all about this enemy in order to learn its tactics, so that we may conquer it. The nature-study lesson suggested should be quite incidental to the interest in this insect as a foe.

Purpose.—To acquaint the pupils with the form of beetles and in particular with the life habits of the potato beetle.

Material.—One or more potato beetles. These may be found in October on or in the earth of a neglected potato patch.

Observations on its form.—The legs are not fitted for jumping because the hind ones are not much longer than the front ones; they

are not fitted for rapid running because they are short rather than long; they are simply adapted for crawling. Incidentally call attention to the fact that there are three parts to the body of the potato beetle, like the grasshopper's, and that the part behind the head (thorax) bears the legs and wings. Note the ornamental markings on the shield that covers the thorax; count the stripes on the wing covers. This beetle is called *decemlineata,* which means ten striped. Are there ten yellow stripes or ten black ones and how are they placed? When the beetle is attacked it escapes by flight. Note when flying how it holds its striped wing covers rigid, while the work of flying is done by the thin wings ordinarily hidden by the wing covers. When the beetle alights note that it folds its wings crosswise and tucks them under the wing covers, just opposite to the way the wings of the grasshopper are folded.

LESSON XVIII.

THE YOUNG OF THE POTATO BEETLE.

Purpose.—To teach the form and habits of the earlier stages.

Material.—A potato plant brought into the schoolroom and placed in a pot. Up to the time of frost the eggs and larvæ may be found in neglected potato patches, usually upon some of the self-planted vines, which still have green leaves.

Observations on the eggs.—Their color; their size; are they placed in groups? Are they placed on the upper or under side of the leaves?

Observations on the larvæ.—When it is first hatched it is pale yellow in color and grows like other insects by shedding its skeleton skin; and when it is fully grown it is bright orange in color and spotted. After it is fully grown it goes down and digs into the earth and changes to a pupa; note how long it takes for the larva to grow from the egg to the pupa and how long it stays in the ground before it changes to an adult beetle.

LESSON XIX.

WARNING COLORS.

Purpose.—To make the child acquainted with the fact that bright colors may be useful to those insects that are distasteful to birds.

Get the pupils to observe the enemies of the potato beetle; they will find that the potato beetle larvæ are not eaten by chickens to any extent, nor will any other birds, except perhaps the omnivorous turkey and the beautiful rose-breasted grosbeak, the partridge and quail feed upon it (*Farmers' Bulletin* No. 54, U. S. Department of Agriculture, "Some

Common Birds in Their Relation to Agriculture"). The reason for this is that the insect is acrid and disagreeable to the taste. By a little questioning get the pupils to see that the bright color of the larvæ is an advertisement to the birds, saying plainly, "Do not touch us, for we are very disagreeable to the taste, and if you do eat us you will have stomach ache." After the bird has tried it once it learns to leave this orange-colored insect alone.

LESSON XX.

HOW TO FIGHT THE POTATO BEETLE.

Purpose.—To give the young gardener methods of protecting the potato vines.

As soon as the pupils are interested in gardens, there should be a lesson on the ways of preventing the ravages of the potato beetle. See "Insects of Garden," and bulletins on spraying.

LESSON XXI

A LESSON IN ENGLISH.

Purpose.—To interest the pupils in the story of the march of the Colorado potato beetle from Colorado to the Atlantic Ocean.

For this story of the effect of a new food plant upon the habits and distribution of an insect species, see "Insects of Garden," by Mary Treat, Orange Judd Co.

THE SQUIRREL.

LESSON XXII.

Preliminary Work.—A squirrel in a cage is somehow an anomaly and it is far better to stimulate the interest of the children in this fascinating creature by getting them to observe it out-of-doors, directing their observations by questions in which the teacher shows a personal interest. These questions may, in part, follow the lines suggested by the following lessons, and the children should be encouraged to give the results of their observations in the form of stories told before the school as informally as possible.

Purpose.—To induce the pupil to notice how the form of the squirrel is adapted to its life.

Observations may be made on squirrels out-of-doors or on a pet squirrel. The squirrel has long, strong hind legs to aid it in leaping from branch to branch of trees. It has eyes at the side of the head so that it can see the enemy from behind as well as in front. It has long, strong,

gnawing teeth to gnaw holes in nuts to get the meats. It also carries its food, like nuts, apples or pears, in its teeth. It uses its front feet like hands, holding its food up to its mouth. It is covered with fur, which keeps it warm in the winter. It has a long, graceful, bushy tail, which helps to steer it when it leaps about the tree tops, and which it also uses as a boa to fold about itself when it curls up in its nest in winter.

LESSON XXIII.

THE HABITS OF THE RED SQUIRREL.

Purpose.—To set the children to observing all the actions of the squirrel out-of-doors.

Things to be discovered.—What does it eat? In stealing pears and apples what part does it eat? In winter what part of pine cone does it eat? How often does it come out in winter? Does it store its food, if so, where? What sort of a home does it have for winter? What about the summer home? What sort of noise does it make?

References.—*Cornell Nature-Study Leaflets,* pp. 435-495. "Squirrels and Other Fur Bearers," Burroughs, p. 1. "American Animals," Stone & Cram, p. 173. "Secrets of the Woods," Long, p. 73. "Familiar Life in Field and Forest," p. 266. "Little Beasts of Field and Wood," Cram, p. 195. "Wild Neighbors," Ingersoll, Chap. I. *Boys and Girls,* Jan., 1903, "Furry."

STORIES OF THE BEAVER.

LESSON XXIV.

Purpose.—To interest the pupil in the animals that were once common in America.

This will need to be a matter of story reading in the higher grades or story telling for the lower grades.

References.—"The Builders in Wilderness Ways," Long; "The Biography of a Beaver," *Forest Neighbors,* Hulbert. N. Y. State Eleventh Annual Report of Forest, Fish and Game Commission, p. 188.

THE CAT.

LESSON XXV.

Preliminary Work.—Most children are interested in this domestic pet to begin with, and most of them have many stories to tell of its interesting ways; therefore, the bringing of a pet cat to the schoolroom with the idea of finding out how pussy is able to get her food, defend herself, wash herself, etc., seems a most natural

and interesting thing to do; or the pupils may make their observations at home. Above all other lessons one should be enforced, and that is the training of kittens when they are young to leave birds alone. They should be punished every time they are discovered watching birds; usually three punishments are sufficient to teach a kitten, that even to look at a bird means danger. The editor has never failed in training a cat to avoid birds when the lessons were administered early enough in the creature's life.

Lessons on this animal have been written up exhaustively, and it seems superfluous to give them again; we suggest the following references: For a thorough lesson on the cat see: "Nature-Study and the Child," Scott, p. 449. "How a Cat Walks," Jackman, pp. 136-137. "Cat as Enemy of Birds," *Nature-Study and Life*, Hodges, pp. 41-312. For supplementary reading see: "Cat Stories Retold," from the *St. Nicholas*. For a delightful history of cats see "The Fireside Sphinx," Repplier. "Familiar Animals and Their Wild Kindred," Montieth, pp. 39-67. Book of Cats and Dogs, Johonnot.

THE SWEET PEA.

Children naturally love flowers and delight to pick them and play with them. This feeling should be utilized as a means to quicken the interest and sharpen the observation, and so lead the pupils to the knowledge that the flower's color, form and fragrance are not alone for our pleasure, but are of use to the flower in its work of perfecting seed.

LESSON XXVI.

Preliminary Work.—If bouquets of sweet peas are brought to the schoolroom from the home garden or the school garden, there will be interesting stories from the children about their planting and cultivation. Interest will be developed in discussing the different colors and different varieties, and when the teacher deems that the time is ripe for a lesson each child should have on his desk two or three blossoms, so that each may read the story.

THE SWEET PEA BLOSSOM.

Purpose.—To lead the pupils to see the different parts of the flower and the way it dusts bees with pollen, and where in the flower the seed is developed.

Observations: Color.—How many colors are found in the blossoms? Is each blossom all the same color, or are some of the petals colored differently from the others? *Form:* The petals of the flower have been named from their position and form. The wide-spread and gayly-colored upper petal is called the banner or standard; the two at the sides are

called the wings; the two lower ones are grown together in the semblance of a little boat, and is called the keel. Folded within the keel are ten, silvery-white threads tipped with orange-colored knobs; these are the stamens; nine of these stamens are united to form a tube, while one lies free along the top. The single pistil is boat-shaped, and later develops into the seed pod. It is tipped with an upcurving style.

Take a sweet pea blossom in the hand and with finger tips press apart the wings and downward on the keel and up flies the stiff, curved style, carrying with it the anthers or pollen boxes, which will leave the finger dusted with the yellow pollen. This is the process by which the bee gets loaded with pollen. It alights on the flower and in reaching after the nectar which lies at the base of the petal, it presses down upon the keel and the pollen is dusted on the under side of its body.

LESSON XXVII.

THE LEAVES OF THE SWEET PEA.

Purpose.—To learn that the sweet pea leaf is not simple, but made up of several leaflets, and that some of these leaflets have been changed to tendrils by which the plant pulls itself up.

Material.—Leaves of the sweet pea and if possible specimens of the leaves of the garden pea and of the locust tree.

Observations.—The pea leaf is compound, that is, it has one leaf made up of more than one leaflet. Note the ear-like stipules at the base of the leaf; stipules when present are always a part of the leaf and a sign that right where they are is where the leaf begins. Compare the pea leaf with that of the locust, and note that there are only one or two pairs of leaflets near the base, while the two or three pairs near the tips have been changed into curly tendrils, which reach out and wrap themselves around any support that is near at hand. The child will readily understand how much more beautiful is the sweet pea vine which has something to climb upon than one which is obliged to grow along the ground. Get the children to notice whether the tendrils all curl in one direction.

References.—"Botany," L. H. Bailey, pp. 110-111; "First Studies of Plant Life," Atkinson, pp. 152-189.

LESSON XXVIII.

STEM OF THE SWEET PEA.

Purpose.—To make the pupils notice the peculiarities of stems and how they are fitted for their work.

Material.—Branches of sweet pea.

Observations.—Compare the stem with that of the China aster or marigold or any stiff stemmed plant to show that while the pea stem is strong, it is not sufficiently rigid to hold the blossoms up. Is the stem round or angular, solid or hollow? Is it rough or smooth? Does it break readily? Note the broad wing or ribbon-like growth which extends almost the whole length of each side of the stem. Owing to the fact that so many of the pea leaves are changed to tendrils, there is comparatively little leaf surface and undoubtedly the wings of the stem act as leaves in manufacturing starch and thus eke out leaf surface.

LESSON XXIX.

THE FRUIT OF THE SWEET PEA.

Purpose.—To have the pupils observe the peculiar way the pods open and the seeds are scattered.

How the sweet pea scatters its seeds.

This should be a study of the sweet pea vines during the last of September or the first of October, and should be field work on the part of the pupils. As the sweet pea ripens, all the moisture is lost and it becomes dry and hard, and through the dampness of the dews at night and the sun's heat which warps it by day, each side of the pod suddenly coils into a spiral, flinging the seed many feet away in different directions as it twists.

THE NASTURTIUM.

LESSON XXX.

Preliminary Work.—Perhaps the many shades of gorgeous colors displayed by these flowers, as well as the peculiarities of the leaves give the teacher a chance to get the pupils especially interested in this plant. The matching of the shades of color and variations may be the beginning to get the child to think more closely of the flower as a whole; then the lessons will follow.

Purpose.—To set the child to noticing how the nasturtium flower is colored and formed.

Material.—A nasturtium flower for each pupil.

Observations: Color.—The different colors found in a single flower. How these colors are placed upon the petals. Note the stripes on the

upper two petals which converge toward the opening to the nectary. Note the color of the calyx, which is somewhat the same color as the flower usually, instead of being green like the calyx of most flowers.

Form.—First note that the upper three lobes of the calyx are grown together into a long tube. Let the pupils see, by taste if necessary, that in the end of this tube is nectar. Note the difference in shape in the bases between the upper two petals and the lower three; notice the fringe on the lower three. Note that the stamens and the little, three-parted style are directly in the path of the insect that would get the nectar from the tip of the long tube. Invite a discussion as to what insects have tongues long enough to reach the end of this nectar tube; only the moths and butterflies that have long tongues, which they usually carry coiled up in a spiral, could reach this nectar. But the children will see the bees working on the nasturtium; the bees could not reach the end of this nectar storehouse, but there is also nectar developed near the base of the lower petals, and the bees feed upon the pollen also.

LESSON XXXI.

THE FRUIT.

In a withering flower get the pupil to see exactly where the seed is being developed. What is the shape of the pod and the number of seeds within it? Note that swinging on the top of a long, bending stem as it ripens, the hold of the seed pod becomes very slight, and it finally breaks off and drops to the ground.

LESSON XXXII.

THE LEAF.

Purpose.—To make the child familiar with this kind of leaf and observe how the nasturtium climbs.

Material.—Nasturtium leaves with petioles.

Observations.—The form of the leaf and the way the veins extend up to the edges like the spokes of a wheel; that the hub of this wheel is not at the center, but always at one side, and is the place of attachment of the petiole. What is the difference in color between the upper and the lower sides of the leaf? This plant climbs by the aid of its leaf stems; these sometimes simply lap over the support holding the plant in place, but sometimes the petiole will wind around a support two or three times. Nasturtium leaves may be found with curious markings upon them. These are made by the little caterpillar of a moth; the caterpillar

mines for its food between the upper and lower surfaces of the leaf, and lives its whole life in this mine until it is ready to change to a moth.

THE PANSY.

LESSON XXXIII.

Preliminary Work.—The children naturally love pansies because of the resemblance which these flowers bear to quaint little faces. They will become still more interested in these flowers after they see the little man with the green head, which grows in the flower as it fades. The pupils should be led to greater interest in the flowers by studying their great variations in color, and getting to know the most popular varieties by name, thus getting them ready for planting the seeds in their gardens during the coming spring. It will be well for the teacher to tell the children how this favorite flower was called heartsease by our ancestors, and that the meaning of the word pansy is thought. There are many beautiful poems which will lead the children to a greater interest in this lovely flower. After the pansies mean something to the pupils, parts of the following lessons may be given according to the grades.

Purpose.—To acquaint the pupil with the details of the flower and to note where the seed is developed.

Observations.—The flower has five petals, the lower one being elongated into a little closed tube, which extends back to the stem between the sepals, making a nectar storehouse. Note the difference in coloring between the two upper petals and the three lower ones; notice that each of the side petals has developed a little velvety fringe, which arches over the hole at the center of the flower. This fringe is probably for brushing the pollen grains from the head of the visiting insects so that they will surely reach the green, round stigma, which may be seen below at the heart of the flower.

Note that the sepals look as if they were fastened on at about one-third their length.

The little man in the pansy.

Take a flower a little past its prime, remove the petals and discover the little man that is seated at the center of the five sepals. He has a green head with his mouth near the top. This head can be seen in any pansy, and the object of having the mouth at the top is so that it may receive the pollen, for it is the stigma. The little man wears a whitish cape with a scalloped reddish-brown collar, and he sits with his bandy legs pushed back in the nectar tube, as if he were taking a foot bath. The cape is made of the five flat overlapping stamens, and the brown

collar is made of the anthers. When the cape is removed the body is seen to be the ribbed seed pod.

THE MILKWEED.

LESSON XXXIV.

THE MILKWEED POD AND ITS CONTENTS.

Preliminary Work.—A milkweed plant near the schoolhouse is the best beginning of this subject. The mechanism of the milkweed flower is so complex, that the study of it belongs to the high school nature work. In studying the plant the most obvious peculiarity is the milky juice which flows from any wound. This juice is not sap, but a special secretion which probably serves two purposes; it is acrid and disagreeable to the taste, and very few grazing animals can be induced to touch it. The milk coagulates and dries very quickly and thus may serve to heal the wound in the plant and keep out microbes. In studying the milkweed compare it with the rubber tree, and make it the basis of a geography story. After the pupils know the plant, lead them to notice the following things.

Purpose.—To give the pupil a comprehension of nature's economical way of putting up seed packages.

Material.—A milkweed pod nearly mature and unopened.

Observations.—Note how we open the pod by pulling it apart along the seam. Note that this is not a raw edge but it is like selvage. A little later as the pod dies it will break open of its own accord along this seam. Note the rough outside of the pod and the smooth, glossy lining, while between the two is a cushion of coarse fibre, and all of this is for the protection of the precious seeds. As the pod is opened notice that within it is something that looks like a fish covered with scales and with a white, silky tail. This is attached to both ends of the pod, but the stronger attachment is at the stem end. Note that the seeds overlap each other in oblique rows; an arithmetic lesson may be given by counting the seeds in a row and multiplying. Lift out one seed, the silk which later makes the balloon lies together like a waxed thread. An interesting subject for a lesson is the action of this silk. Place a seed with the silk attached in the sunshine, the seed lying flat on the table. Very soon the fibers of the silk will begin to separate and curl back, and will soon lift the seed into an upright position. In a minute or two each delicate fiber will have moved off by itself as if it were alive, and the balloon is complete ready for the first wind that blows. Take this fish-like body from the milk-weed pod and remove the seeds one by one, taking off first the top row and then the one beneath, and thus unravel this seed and silk package and learn to admire the perfection of its arrangement.

Experiment.—Drop a milkweed balloon on water; note that it will float for a time and that after the silky fibers become matted in the water,

the seed itself still floats. With the scissors cut off the corky margin of the seed; put it back in the water and note that the seed sinks. This shows that the corky margin is a life preserver to keep the seed afloat should it happen to fall in a stream.

References: "Nature-Study and the Child," Scott, p. 371.

LESSON XXXV.

A MILKWEED LEAF.

Object.—To learn from drawing the shape of the very interesting venation of this beautiful leaf.

Note the great difference in the colors of the leaves above and below. Note that on the stem the leaves are arranged in pairs, each neighboring pair pointing in opposite directions.

AUTUMN FLOWERS.

LESSON XXXVI.

It is unfortunate for the teacher that many of the showy flowers of autumn belong to the compositæ, and are most complicated and highly developed in structure, and quite difficult of comprehension to the child or the beginner in botany. Yet these flowers are common and attract the children and something of interest should be taught concerning them. In the primary grades the learning of these flowers by name is sufficient; (see Mrs. Wilson's "Elementary Nature-Study," pp. 11-16). But in the upper grades something more should be taught.

Preliminary Work.—For all these flowers which live in families, villages and cities, the work should begin by using them for bouquets in the schoolroom. The children should know each by name, where it is found, and be generally familiar with the plants on which the flowers grow. Poems may be read about the flowers, or stories told of them, so that the pupils are thoroughly interested in them before the lessons are given.

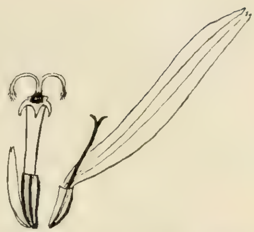
THE SUNFLOWER.

LESSON XXXVII.

Purpose.—To lead the pupil to observe flowers closely and to teach him that some which look like simple flowers are composed of a great many little flowers, living together like a family.

Material.—The great Russian variety planted for the seeds is an excellent type for this study. Among wild species the false sunflower or ox-eye shows the flowerets most distinctly.

Observation.—The central circular part or disc of the flower is composed of a great many tiny, tubular flowers standing very closely together. Take one of these out, place under a lens to show that it has stamens, a pistil and a corolla that is tube-like. Compare this little floret with any large flower with tubular corolla, like the morning-glory, harebell or gentian. Let the pupil study it until he sees that it is a perfect flower.



Central flower and banner flower of the ox-eye.

Next take off one of the ray flowers and show that its corolla instead of being lobed like the others is extended out at one side in a banner. Under the lens see if this flower produces a seed.

A COMPOSITE FLOWER.

THE WORK OF A FLOWER FAMILY.

Purpose.—To acquaint the pupil with the different duties of the banner flowers and the center flowers.

After these two types of the flower have been studied show the work of each in the flower family. The business of the central, perfect flowers is to develop seeds, each one producing one seed; the work of the banner flowers around the edges is to wave their banners to attract the insects, say as plainly as any flag signal can say, "Come right this way and get some pollen." Usually most of these flowers have no

Burdock. *Aster* *White Daisy.* *Thistle.*

Enlarged drawings of the flowers.

nectar but attract insects by the pollen. The banner flowers are the advertising agents for the whole family, for if they did not hang out

their flags around the edge of the home or out of the windows, so to speak, the little flowers in the center would not be seen and would be neglected by the insects.

LESSON XXXVIII.

FLOWER VILLAGES.

Purpose.—To enable the child to discriminate between the flowers which attract attention by growing in masses and those where the single flower is showy enough to attract insects.

When many of the flower families are grouped together on one plant they may be compared to a village; asters, burdocks, thistles and sunflowers are good instances of these flower villages. It should be shown clearly that by this growing of many of the flower families together, they make a greater show of color and are more likely to attract the attention of insects.

Central flower. Banner flower
Golden-rod.

The golden-rod may be compared to a flower city, each little branch bearing, as it does, many families of blossoms like a street. The golden-rod flower should be looked at under the lens to show that each little tuft of yellow is made of disc flowers, and banner flowers similar to those of the sunflower.

Reference.—"A Golden City," *Boys and Girls,* Oct., 1904 (Ithaca, N. Y.). Bulletin No. 6, *Bureau of Chemistry*, "The Sunflower Plant: Its Cultivation, Composition and Uses," H. W. Wiley, p. 31, 1901; price 5 cents.

A golden-rod street.

LESSON XXXIX.

THE SEEDS OF THE SUNFLOWER.

Purpose.—To teach that the chief end of each floweret is to develop seed.

This should be a lesson of observation covering several days. The children should see where the seeds are being developed, and should

watch them mature. To a child properly taught the dying blossom should mean the growing and perfecting of the seed; and they should not feel sorrow at the fading of the flower, but joy in its fruition. In connection with the seeds of the sunflower the gold-finches should be studied, as they visit the sunflowers in flocks. Also the fact should be brought out that sunflower seed is good chicken food, and the people in Russia sometimes grind it for bread.

LESSON XL.

Purpose.—To teach that each flower family has its own way of planting its seeds.

After the pupils observe that the seeds of the golden-rod, aster and thistle develop fuzzy balloons which the wind carries and plants in different places, let them observe that the burdock-bur is a box full of seeds with hooks all around it to catch on to any passing creature and thus be carried away. The sunflower shakes out its seeds and trusts to the birds to carry a few of them away for planting, while the daisy sifts its seeds with the aid of the wind, and often scatters them in the grass or clover seed, which the farmer sows the next year.

References.—The Burdock, Nature-Study and the Child, p. 389. "Plants and Their Children," p. 52.

CHAPTER IV.

LESSON XLI.

STUDY OF LEAVES IN PRIMARY GRADES.

Purpose.—(a) To teach the child some of the ways in which leaves are related to the remainder of the plant. (b) To draw out the fact that there is a great difference or variation in leaves, and thereby to lead on later to the fact of variation in general. (c) To interest the pupil in form and color.

Preliminary Work.—During the autumn in the eastern United States, the attention of the children should be attracted to the leaves by their gorgeous colors. It is well to use this interest to cultivate their knowledge of leaf form and of trees, but this teaching of the tree species to the child should be done incidentally and guardedly. If the teacher invariably says, "this is a hickory leaf or this is a white oak leaf," the pupils will soon follow her example, quite unconscious of the fact that they are learning the leaves by name. After they have become thoroughly interested in leaves, as they will if they make collections for pressing and for ornamenting the schoolroom, they should somehow be taught through their own observations, the fact that leaves are a necessity to the life of trees and of plants.

Observations.—If possible, make the observations on leaves that are still on the plant. A window plant may answer; but it is better to have the first observations made in the open. Do leaves have any relation to light? Are they borne near the ends of the twigs? Where do you find the biggest leaves? Are the stalks all of equal length? Why? In the window note how the leaves turn towards the light. Do the leaves change color where there is little light?

After the study of leaves in the fall comes the effect of frost on vegetation and the pupils should discover for themselves that when the plant or tree dies there are no leaves left upon it. This lesson should be taught in many forms so that the child will realize that leaves are an important part of the life of the plant.

To relate the work to the life of the tree, competition may be started to see whether any pupil can find two leaves alike upon any tree. This should be done after the leaves have fallen so that the pupils may gather leaves from the ground. This will be the best exercise of all in teaching the children close observation.

LESSON XLII.

Purpose.—To lead the pupil to notice differences in color and form of leaves.

Material.—Let the children bring to school leaves of all sorts, which have autumn tints. They will be especially interested in picking up the bright colored leaves that fall from the roadside trees.

1. Let them classify the leaves according to color so as to train the eye to discriminate the tints and color values.

2. Let them classify leaves according to form, selecting those which resemble each other.

3. Have them tell in what respects they resemble each other, in this way incidentally calling attention to the margins, the veins and the petiole.

4. Teach the names of the leaves of the most common trees by mentioning *quite incidentally* that certain noticeable leaves are the maple or oak or elm, etc. The children will quickly pick up these names by themselves if thus taught, and the knowledge will help them later on.

5. Let each child select a leaf of his own choosing and draw it. This may be done by placing the leaf flat on paper and outlining it with pencil, later drawing in the veins, or the drawing may be made with colored crayon freehand. The pupils should be allowed to please themselves in this matter, as it is not a drawing lesson but a lesson to help remember form and color.

6. Let the pupils select paper of a color similar to the leaf and cut out the leaf from it during busy work.

7. Let each pupil select four leaves of maple or oak as nearly similar as possible and press them in his book, and later arrange them on a card in some symmetrical design. This may be done while the leaves are fresh, and the card thus arranged may be pressed and thus preserved.

THE OAKS.

Black Oak. *Red Oak.* *Scarlet Oak.*

These have leaf-lobes sharp-pointed and the acorns are bitter and require two years to mature.

LESSON XLIII.

THE SHAPES OF LEAVES.

Preliminary Work.—In the quest of autumn leaves the children will learn to know where the different oaks grow, and this is perhaps the best way for them to learn the oak trees. There are very many helps in literature to cultivating an interest in the oaks, and these should be used judiciously. The wise teacher will realize just how far "memory gems" and literature will add to the interest of nature-study; for just a little beyond this lies the possibility of tiring the pupils of the subject.

Purpose.—To lead the children to notice the difference in form of different kinds of oaks.

Material.—The leaves from all of the oak trees in the vicinity.

Observations.—There are two general shapes of oak leaves, one that has the lobes rounded, and one that has the lobes sharp and tipped with sharp points. Those that have the rounded lobes are the white, bur, post and chestnut oaks; those that have the divisions ending in a sharp

Chestnut Oak. *White Oak.*

These have lobes of leaves rounded. The acorns are sweet and mature in one year.

point are the black, red, scarlet and pin oaks. Those leaves with the pointed tips are nearly as smooth on the under side as on the upper, while those with rounded lobes are more or less rough on the under side and quite a different shade of green than is the upper surface.

These leaves should be carefully drawn and incidentally labelled. In the lower grades the leaves may be mounted and pressed, and if the children remember their names they may put on the labels.

References.—"The Tree Book," Rogers, pp. 190-228; "Our Native Trees," Keeler, pp. 323-377; "Trees of Northeastern America," Newhall, pp. 101-128.

LESSON XLIV.

THE ACORNS.

Purpose.—To get the child to think that the acorn is the seed of the oak, and to notice the differences in the kinds of acorns and that some acorns are edible and some bitter.

Observations.—There are some differences between the acorns of the oaks of the round lobed leaves and those of the pointed lobed leaves, for the former mature their acorns in one year and the acorns are always situated on the new wood, while the pointed lobed group require two years for maturing the acorns, and they are always situated on the last year's wood. Also the round lobed group have their acorns on stems, while the others grow their acorns very close to the branch. The acorns of the white and chestnut oaks are sweet and almost as good as chestnuts; in fact much appreciated by the squirrels and chipmunks, while the acorns of the sharp tipped oak leaves are bitter. But many of these acorns are great favorites with the children, as the red oak furnishes little housekeepers with cups and saucers for tea parties. These acorns are large, the cup is deep and the saucer broad and flat, each needing just a slight rub on a stone to remove the point from the acorn and the stem scar from the saucer to make them sit up straight. The acorns of the scarlet oak are used by the boys for tops, as they are particularly well balanced and will whirl for a long time. After the acorns are studied they should be planted, and when they begin to grow the seedling tree should be studied.

THE CHESTNUT.

LESSON XLV.

THE LEAVES.

Preliminary Work.—No extraneous interest need be added to the study of the chestnut if the pupils have access to the country. Almost anything that the teacher can tell them about this favorite tree or can teach them about its ways of life would be sure to be well received.

Purpose.—To enable the child to know the chestnut leaf as soon as he sees it.

Observations.—There are very few leaves that look at all like the chestnut leaf, although the leaves of the yellow chestnut oak resemble them somewhat. There is no way to fix the shape of a leaf in the mind like drawing it. In the upper grades the drawing should be made of a twig with the leaves on it to show their alternate arrangement, and much care should be given to making the toothed edges with bristled points and concave scallops between.

References.—The tree books referred to above.

LESSON XLVI

THE CHESTNUT FRUIT.

Purpose.—To get the pupil to see the way chestnuts grow.

Material.—The chestnut bur.

Observations.—The outside of the bur is very spiny and this protects the young, growing nut from attacks of squirrels. Induce the pupil to think that the reason for this protection is that the chestnuts may mature and be planted and grow up into other chestnut trees. Note that the inside of the bur has a velvety lining, which makes a soft wrapping for the young and tender nut. Note how difficult it is for us to open the bur; then study a bur opened by the frost. There are four hinged doors which Jack Frost swings open.

In studying the chestnut itself observe the following: The marking at the large end, which shows where the nut was fastened to the bottom of the bur. Notice by the shape of the nut how many grew in a bur; if only one it will be large and almost round; if two each one will be approximately half a sphere; if three there will be one with two sides flattened. A chestnut should be planted where it may be observed and the seedling tree studied. In connection with the chestnuts and acorns, the habits of squirrels and chipmunks should be studied and the assistance which these animals incidentally give to planting the nuts in localities quite distant from the mother tree.

THE MAPLES.

LESSON XLVII.

As the maples give us our most gorgeous coloring they are naturally among the first to attract the children's attention. The mountain, the striped and the sugar maples ripen their seeds in the fall, and the quest of seeds, and the way they are planted beneath the trees may be a part of the interest of the excursions after the leaves. The red and the silver maples mature their seeds in the spring. The different colors of the leaves of the red and sugar maples in the autumn should be observed and the fact that the red maples are the first to lose their leaves. Suggestions and information should be given to the children before they go in quest of their maple leaves, that their eyes shall be open to other facts about the maple leaves than the color of the foliage.

The same plan should be followed as given for the study of the oaks. For this lesson see Cornell Nature-Study Leaflets, p. 428.

PEACH, PEAR AND PLUM.

LESSON XLVIII.

Preliminary Work.—There is little occasion for trying to cultivate the pupil's interest in fruits, because they have one natural interest in them that is all-absorbing. Thus the work should be to widen the pupil's horizon by making him comprehend that these fruits have a special use to the tree, and are for the purpose of preserving the plant and seed. Much should be made of the fact that man has developed a greater thickness of pulp in all of these fruits for his own delectation.

In studying these fruits the object should be to develop in the pupil's mind the idea that these fruits were developed for the sake of the seeds within them. Incidentally the pupils should be told that these fruits grew wild before they were discovered by man, and they should see in each case just how the seed is protected inside the fruit. The seeds should all be planted where the children can see them and the growth of the seedlings watched.

References.—"Plants and Their Children," Dana, pp. 31-33; for carefully worked out observation lessons see "Nature-Study with Common Things," Carter, pp. 21-33.

LESSONS ON SOILS AND PLANTS FOR PRIMARY GRADES.

By JOHN W. SPENCER.

To the Teacher:

I wish that you would try some of my theories on your pupils when you have a little time at your command. This is nothing more or less than giving them some instruction in agriculture; yes, with children as small as your first and second graders. I would have you show them some things that grayheaded farmers—good farmers, too— have never understood. My notions may sometimes be beyond the understanding of children as small as yours but not beyond that of yours, nor beyond what you ought to understand in order to make your teaching clear and vivid to them. Neither do I expect that you will try to teach all the points that I hope to bring out.

Puritanic instruction that I received in my childhood days gave me the idea that climbing up hill was virtue mainly because it was disagreeable, and sliding down hill was wrong mainly because it was fun. I would have you reverse this idea in your teaching and make a virtue of the easy way. I hope I may lead you to become an opportunist rather than to be dogmatic. Learn to accomplish your purpose by rowing down stream rather than up, and you will have fewer blisters on your hands. For years I have had profound respect for the form of diplomacy that catches flies with sugar rather than with vinegar. To illustrate the few principles that I would have you give your pupils, I have chosen the mud-pie and sand-pile method because I know the children will enjoy that type of instruction.

On the first pleasant Friday afternoon of your coming term of school I would have you take your pupils out for a walk. You may call it a field excursion, if that term sounds any better. Tell them that you are in search of

A Mill Where Stone Flour is Made.

By the way, how many people know the process of soil-making? How many know the life history of the clods which will some day fill the graves that hold their bodies and that, too, people who have a record for scholarship?

In choosing your path for the afternoon walk, take one leading to the nearest brook. There you will find the water flowing in ripples and eddies. The children can determine the difference in the swiftness in flow of water by tossing chips and dry leaves on its surface. The reason why they travel faster over the ripples than the eddies is the same that makes a sled go down a steep hill faster than on a road which is nearly level—the steeper the hill the faster the sled runs. The water also is more shallow and makes more noise in the ripples, hence the proverb that " Still waters run deep." Examine some of the stones in the ripples and see how the edges are rounded. They became so by bumping against each other in their travels. Stones with rounded, smooth edges and sides have been great travelers. Many have come long distances and all have been on their journey a long time. Stones with sharp edges are stay-at-homes. They are not far from the spot of their origin

If the day be a warm one the youngsters will enjoy taking off their shoes and stockings and wading in the brook. Put some stones in an empty stocking, lift the leg and let the stones roll towards the toes and then lift the toe and let the stones roll back again. If this process be continued long enough the stocking will stand in need of darning. The children will understand what your illustration stands for without carrying the demonstration that far. The stones while in the stocking may also wear off to some extent, but the amount will be so small that only the most delicate scale would show it. Why did the stocking wear most? Because the stones were harder.

How Soil Goes Swimming and Takes a Journey.

After a while the stone particles are so small that the tiny pieces swim when the water has any motion. When there are a large number taking a swim we say the water is roily. An interesting demonstration may be given the children by filling a tumbler with roily water and when the water has evaporated, examine the grit on the sides and bottom of the glass. It is this fine stuff that helps to make the inorganic part of soil. The amount of grit that may be found in a tumbler may not be

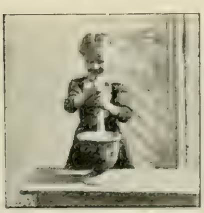
greater than a dose of bitter quinine and you think it is too small to be thought of as a factor in the formation of soil. Consider, if you please, how small your glass of water was compared with a river filled from bank to bank with roily water. Think of the results if the river of roily water should overflow and the fine soil be deposited over the adjoining fields. The amount dropped by one such overflow might be but the fraction of an inch, but when it has happened a hundred times the accumulation would be worth considering.

But what becomes of the harder stones that start out on the journey? When the softer stones became so fine that they swam away, the harder stones continued to thump each other and rub against each other as they did in the stocking. Now when all the remaining stones are hard it becomes a case of diamond cut diamond. They continue to grind each other day and night, week days and Sundays, through decades and centuries. A stone that wears others not only makes them smaller, but becomes smaller itself. That the children may understand what force moves the stones, scatter some sand in the ripples where the current is the strongest and watch the moving water catch the sand and waft it down stream. The larger the stones the stronger the current necessary to move them, and as a consequence the smaller stones travel faster than the larger ones. In the game of one stone grinding another, when the smaller ones are ground down to the size of pin heads, we have what?—grains of soil. After all, a grain of soil may be only a small stone—but large enough to be a back load for an ant. You now have means of showing in a generic way how sand is sometimes made. There are other soils. One is clay soil and may come from another kind of rock. While some of it is reduced to powder by a process much like that which grinds the stones in the creek, most of our clay soil comes from rock by quite another kind of mill.

How Stone Flour is Made by Weathering.

On your trip going or returning, I hope you may find some shale rock. This will be the softest rock of which you know and contains no grit. The action of the frost, sun and rain has softened and torn it in pieces, which you will often find in piles of flakes. The most probable places where such rock may be found will be in the cut of the road or where the stream curves at the base of a cliff. Some of your pupils may be made to understand that the rock crumbs have been broken from the walls by the power of Jack Frost and his helpers, the sun and storms. Jack's work may seem to proceed slowly, but it goes on continually and with no idle moments. Fill a paper bag with the rock crumbs and take them back to the school room. At a time when the weather does not permit of field excursions, the pupils may make as much artificial clay in a comparatively short time as would keep Jack busy for several years. Yet it would be well to impress on the minds of the children that while Jack may seem to do work slowly, a hundred tons to him is no more than an ounce to first and second graders. It is well to say to them, also, that soil has undergone many other changes since it was originally pulverized; but this subject is not adaptable to small children.

The most expeditious way to pulverize the shale is in a mortar and when finely crushed add enough water to make the rock flour as stiff as putty. Let your children mould some of it into marbles and small plates and let them dry. To another lot of artificially made clay add about one-half sand and when wet mould more marbles and let them dry. This last lot will not have the stick-together quality that had the first. The sand has made the difference, and why? For a third experiment, let the children mould some more marbles—at least try to—with only a small quantity of water added to the crushed shale and they will quickly realize how difficult it will be because there has not been enough water used to make the clay sticky. The lesson sought is to impress on the minds of the children the fact that if they have a garden on clay soil and they hoe or spade it when wet the seed-bed will be lumpy and not soft and fine such as seeds like best. If they wait until the clay garden is partly dry cultivation will then make it "mealy" and will give a downy bed of ease for seeds or plants.



SOILS FOR CHILDREN'S GARDENS.

There is no doubting the plant fertility contained in clay, but because of its tenacity—its stickiness—it must be carefully tilled by the husbandman and if possible avoided by the child gardener. If the clay soil of a child's out-of-door garden is small and a supply of sand is convenient its tenacious character may be much modified by spading the sand and clay together. Rotted leaves are also helpful. It was to demonstrate this fact that I suggested the mixing of sand and clay and rolling the combination into marbles, which must prove a failure. To go much farther in this direction in the study of the formation of soils and to add another step and treat of the addition of humus, belong to higher grades than yours. If you enable the children to tell their parents that the larger part of soil is made of stone flour and they know the mills where some of the grist is ground, you will have taken a good first step.

In giving demonstrations of seed germination in stone flour you will find sand more desirable than clay. Why? Because it is cleaner. Why is it cleaner? Because wet clay is sticky and is pure mud and it cannot be brushed from the clothing and hands like sand. All this is due to the exceedingly fine particles into which clay is divided. Grains of sand are as large as pin heads; particles of clay are even smaller than pin points.

A Recipe for Sand-Pies.

First get your sand and then the dishes for your pies. Egg shells may be used and are the cheapest, but not the best. Empty cans also may be used. Personally I like quart berry baskets. If the latter are used, do not fill them more than one-half or three-quarters full, for the weight of the wet sand will find the weak spots in the receptacle after three or four weeks use. The flower pot of the florist, those three or four inches in diameter, are very good and are not expensive. If egg shells or cans are used it is necessary that holes be made in the bottom for drainage. The necessity for this you may explain to the children is to keep the plants from having wet feet. Such an explanation will meet their understanding, and be near enough the fact to answer the purpose. The subject of drainage, film moisture and oxidation will be more

appropriate for the grammar grades. It is better to make a planting every four or five weeks than have one planting lasting eight or ten

weeks. The idea is not to take the plant to adulthood but rather to become familiar with its childhood. You must not think this scheme a failure because you find it best to abandon a planting and begin again. It is in the beginning where lies the most important lessons to the children of the ages of your pupils. For quick germination I know of nothing better than peppergrass and radish and to young children this is desirable for the reason that they are impatient for results. Corn, peas and beans

are desirable as lessons in germination. "How a squash plant gets out of the seed," is one of the best lessons in that particular that I know of. Do not think that you must teach all the points there mentioned. Remember the capacity of your pupils.

The plan most popular with the pupils is for each to have individual farms and to plant seeds of their own choosing. The collection may be placed in a shallow box covered with sand. As a privilege, a child may be permitted to take his farm to his desk for a short period observation.

The question of watering plants in pots, vases and boxes is an important one. It is more wisely performed when done by principle than when done by rule. The amount of evaporation does not go by rule and no rule can be given in applying water.

Seed Lunches.

A moist soil.

After a child has sown the seed and germination has begun his thought will be the maintenance of life in the plant. To have it decline in vigor and die will be a regret to him. I am wondering whether the fact will be beyond the comprehension of your first and second grades, that the greatest struggle that an adult plant has is to produce a lunch of starch that will maintain the embryo plant until it has passed out of plant childhood and can make its own living by means of the soil, light and air. Every plant may be said to have an impulse to keep its own kind in continuous existence. I have suggested that you plant the seed of peppergrass (a variety of cress) and radish seed in sand; but you must not expect that the seed will develop adult plants, for the reason that sand contains but little available plant-food; yet by keeping

it moist it will develop or make usable food that lies in the seed and will carry the plant into, say, a youthful stage. When all the resources of the lunch have been absorbed the plant will, to use a child's language, become hungry and die from starvation. If your pupils were in some of the higher grades I would suggest that before the hungry period begins some of the plants be transplanted to pots containing fertile soil and part remain in the sand. Give each the same care and observe how the plants in fertile soil will begin to elaborate their own living.

A dry soil.

I hope you will not fail to get Cornell Nature-Study Leaflets and take from the lessons "How a Squash Plant Gets Out of the Seed" such features as you think are adapted to the understanding of your pupils.

Two Plants for the Schoolroom Window.

You may have an inquiry in your mind about some plants that you may have in your schoolroom, more for their beauty than for instruction. I would recommend for that purpose the Chinese lily and Paper White narcissus. The latter is the cheaper of the two—35 cents per dozen I think—and will give blossoms a little earlier than the former. Both are given the same kind of treatment, which is to place the bulbs in a shallow dish, place enough pebbles about them to keep them upright when the flower stalks become top-heavy, and keep the dish supplied with sufficient water to cover two-thirds of the bulbs. As there is little direct plant food in the water the question arises, what sustains the growth? Simply the food stored in the bulb by the parent during the preceding years' growth. By the time the flowers have died that store of food has been exhausted. The same is true of hyacinths grown in water; but hyacinths grown in pots of soil will partially recover when replanted in the open ground.

I am hoping to hear from you soon after the receipt of these suggestions. I am wondering whether you will tell me that in many things I am away beyond the understanding of your little ones, that I must have

forgotten how young first and second grade children are. You must recall that I have been talking to you and not your pupils and have asked you to select anything that in your judgment is practical to give them as instruction.

Cornell Nature-Study Leaflets is a reprint of leaflets issued through a series of years intended for the benefit of teachers and children interested in the common things about them. It is profusely illustrated volume of 600 pages comprising 130 topics. This is sent to actual teachers in the Public Schools in the state of New York on remitting 30 cents for postage and expense of mailing. When making application, explicitly state where and what grades you are teaching.

IN NATURE-STUDY TELLING IS NOT TEACHING.

Do not tire the child with questions; lead him to question you instead.

An object lesson upon some animal or plant is not necessarily a nature-study lesson. An object lesson is for the purpose of mere observation, and a nature-study lesson includes both observation and understanding.

Be sure that the pupil is more interested in the object than in the questions about the object.

The object of nature-study teaching should be to interest the child in nature and not to weary him with it.

Home Nature-Study Course

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By ANNA BOTSFORD COMSTOCK and JOHN W. SPENCER.

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BOOKS REFERRED TO.

"A Guide to the Trees," Lounsberry; "American Animals," Stone & Cram; "Animals," Hamerton; "Animal Heroes," Thompson Seton; Audubon Educational Leaflets, 525 Manhattan Ave., New York City; "Aztec Treasure House," Janvier; "Black Beauty," Sewell; "Birds in Their Relation to Man," Weed & Dearborn; "Birds of Village and Field," Merriam; "Cornell Nature-Study Leaflets;" "Daddy Darwin's Dovecote," Mrs. Ewing; "Familiar Animals and Their Wild Kindred," Montieth; "Familiar Life in Field and Forest," Mathews; "Familiar Trees and Their Leaves," Mathews; "First Book of Birds," Merriam; "Friends in Feathers and Furs," Johonnot; "Innocents Abroad," Mark Twain; "In the Main Woods," Thoreau; "John Brent," Theodore Winthrop; "Little Journeys to Mexico," "Lives of the Hunted," Thompson Seton; "Neighbors with Claws and Hoofs," Johonnot; "Neighbors with Wings and Fins," Johonnot; "Nights with Uncle Remus," Harris; "Our Native Trees," Keeler; "Our Own Country," Smith; "Sam Lovell's Camps," Rowland Robinson; "Songs of Nature," John Burroughs; "Squirrels and Other Fur Bearers," John Burroughs; "Story of the Donkey," From the French of Countess de Segur; "Tannenbaum," Hans Andersen; "The Tree Book," Rogers; "Travels on a Donkey," Stevenson; "True Bird Stories," Miller; "Two Little Savages," Thompson Seton; "Under Sunny Skies," "Watchers in the Woods," Sharpe; "Wild Animals I Have Known," Thompson Seton.

TEXT BOOKS.

"The New Agriculture," Collins; "A Country Reader," Buchanan; "Agriculture for Beginners," Burkett, Stevens & Hill; "Botany," L. H. Bailey; "Manual for the Study of Insects," Comstock; "First Book of Forestry," Roth; "First Studies of Plant Life," Atkinson; "Injurious Insects," Treat; "Lessons in Elementary Science," Seaman & Woodhull; "Nature-Study," Jackman; "Nature-Study and Life," Hodge; "Nature-Study and the Child," Scott; "Nature-Study by Months," Boyden; "Nature-Study First Reader," Willson; "Nature-Study with Common Things," Carter; "Plants and Their Children," Dana; "Special Methods in Elementary Science," McMurray; "Study of Nature," Oakley.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

"Beans, Peas and Legumes as Food," Bulletin No. 121; "English Sparrow in North America," "Food of Nestling Birds," Reprint from Yearbook, 1900; "Relation of Sparrows to Agriculture," Bulletin No. 15; "Some Diseases of Beans," Cornell Bulletin No. 239; "Squab Raising," Farmers' Bulletin No. 177.

JOURNALS.

Boys and Girls, 50 cents per year; *The American Fancier,* 1.75 per year; "*The Squab Bulletin,*" 50 cents per year.

HOME NATURE-STUDY COURSE

TEACHERS' LEAFLET.

BASED ON THE WORK FOR FIRST AND SECOND YEAR PUPILS AS OUTLINED IN THE SYLLABUS OF NATURE-STUDY AND AGRICULTURE, ISSUED BY THE NEW YORK STATE EDUCATION DEPARTMENT.

The lessons in this leaflet deal with topics suggested for the first two years' work in the syllabus of Nature-Study and Agriculture issued by the New York State Education Department. The editors feel that it is not for them to say just how much or how little should be taught in the primary grades, as this matter must be settled individually by the primary teachers. Therefore, these lessons contain enough subject-matter so that they may be adapted to any grade. The lessons are planned to be short. Many supplementary lessons are suggested, which deal with the literature of the topic under consideration; this is done because we believe that after the pupil has discovered as much as he can for himself about an animal or plant, he should seek such further information as will make the subject more interesting and seem more alive.

Pouter Pigeons.

The editors wish to acknowledge their indebtedness to Miss Ada Georgia for assistance in preparing this leaflet.

PIGEONS.

Preliminary Work.—If there are pigeons kept in the neighborhood the work may be done by letting the pupils observe these birds out-of-doors; this is the most desirable way of giving the lessons. Begin with a few questions which will arouse an interest in the birds or with a story of their history, or by reading the stories of carrier pigeons in order to arouse interest in the birds. A pigeon in a cage in the schoolroom for a special lesson would be a help after the field notes have been made.

LESSON XLIX.

THE HABITS OF PIGEONS.

Purpose.—To draw the attention of the pupils to the way pigeons act, and to relate these actions to their life necessities.

Where and on what do the pigeons feed? They are often seen in the road; what do they find there to eat? An interesting fact about pigeons is that they are very fond of salt, and though they are seed-eaters, they will take bits of salt codfish for the sake of its savor. Note that pigeons drink like a horse and not like a hen; that is, they drink without lifting the head to let the water flow down by gravity. Note the peculiar way pigeons nod when walking, as if the head were in some way attached to the foot, and notice that this peculiar movement sends waves of sunlight over the shimmering colors of the bird's plumage. Call attention to the peculiar flight of the pigeon, and be sure that the children can identify them in the air from other birds. Ask them to describe the difference between the flight of the pigeon and that of the crow and of the hawk. Let the pupils study the cooing of the birds, and tell how many notes there are and if possible what they mean.

LESSON L.

A STUDY OF THE APPEARANCE OF THE PIGEON.

Purpose.—To accustom the pupil to see quickly and accurately a bird's appearance and to remember what he sees.

This should be a lesson of observation out-of-doors. If there are pigeons near-by it may be a recess exercise, letting the pupils go out to observe the birds and tell what they can remember of a bird's appearance when they return. They should remember the following things, if not at first, through practice in this sort of memorizing: Colors of the head, neck, breast, back, tail, beak, eyes, legs, feet, claws.

This will prove most excellent training for fitting the pupils later to observe colors of the wild birds.

LESSON LI.

PIGEON HOUSES.

Purpose.—To teach how pigeons should be comfortably housed.

This is very good work for the pupils in the manual training class. Whether there be manual training in the school or not, boys enjoy carpentry work and like to build bird houses. The Rock pigeon from which our pigeons descended nest in caves and holes in the rocks and never in trees. Formerly in America pigeons were housed in the gable ends of barns,

but later the "dove cotes" have come into general use, as this method is more satisfactory to both people and birds. There are certain rules to be followed in building an apartment house for pigeons. It must be high enough from the ground to keep the nests safe from rats and weasels; each little compartment should be at least 16 inches wide and a foot from front to back and comfortably high; the door should be at one side of the compartment so that the nest may be completely hidden; in front of each door must be the little shelf to act as a balcony on which the parent bird that is taking a rest may sit and coo to relieve the tiresome task of the one which is keeping the eggs warm. The cote should be painted white, as pigeons like that color best.

LESSON LII.

NESTING HABITS OF PIGEONS.

Purpose.—To call the attention of the pupils to the following points: The method of nest building; the number of eggs laid, their size and color; the length of the incubation period. Note whether both parents sit on the eggs and feed the young. Note the devotion of the parents to each other; the length of time required for the young to mature; how many broods are raised each year.

Some breeds of pigeons mate for life. Two eggs are laid for a setting, and ninety per cent. of these hatch into a male and a female, and these are likely to mate unless interfered with. The happy domestic life of the dove cote has been celebrated since the time of Pliny. The parents are very devoted to each other and are both very devoted to the young; they share equally the hardships of sitting on the eggs; and feeding the young. In the crops of both parents is secreted a cheesy substance known as "pigeon's milk." This food is given to the squabs for about five days and is then replaced by grain which is softened in the parents' stomachs until the young are old enough to feed themselves. All this food is very nourishing and the squabs get very fat, often weighing more than the parents when they are ready to leave the nest.

LESSON LIII.

THE ENEMIES OF PIGEONS.

Purpose.—To teach children how to protect the pigeons.

All of the creatures, which feed upon chickens will take pigeons if they can get them; these are weasels, hawks, owls, and especially the crows when they can get at the young pigeons; but perhaps the most common enemy is the rat. The dove-cotes must be mounted on a standard which the rat cannot climb. For interesting account of the rat see "Amer-

ican Animals," Stone & Cram, p. 142. Note that the pigeons have no means of defense, their only escape is by flight. For supplementary reading, see lesson X of this series.

LESSON LIV.

DIFFERENT BREEDS OF PIGEONS.

Purpose.—To interest the pupils in different varieties of pigeons, and to make them understand that these have been developed by man.

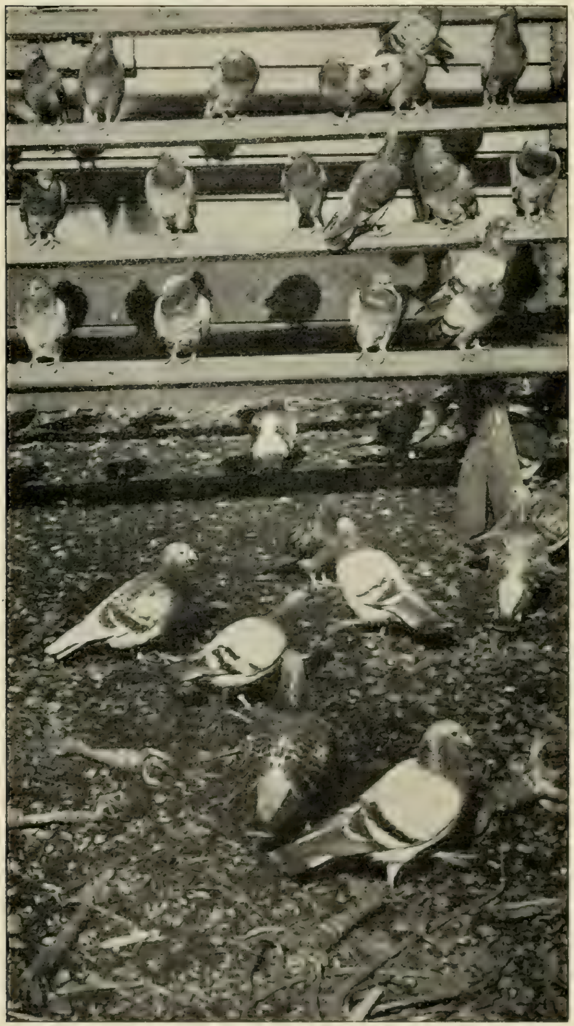


Photo. by Verne Morton.

Antwerp Homer Pigeons.

The poultry shows at fairs or elsewhere afford the best opportunity for interesting the pupils in the different breeds. There are over one hundred and fifty kinds of domestic pigeons all of which are supposed to have been derived from the Rock pigeon, a species native to Europe and Asia. London is the center of pigeon fanciers, and there the best of the fancy varieties bring large prices.

The first mention of domestic pigeons is over 3,000 years ago. Pliny speaks of Romans who were ardent fanciers who told with pride of the breeding of their favorites. The common pigeon was brought to America by the early settlers, probably the Dutch and Huguenots; later we received importations from England, Germany, Belgium, Holland, India and China.

Of the many varieties bred to-day only four are recognized by fanciers as having been bred to approximate perfection. These first royal four are: The carrier, the pouter, the barb and the short-faced tumbler. Second, are those varieties which possess distinctive qualities regardless of color and having a strong tendency to transmit them to their young. These are: Jacobins, long-faced tumbler owl, oriental frill, turbit, fantail, show-antwerp and runt. Third, come what are known as toy pigeons, which depend almost entirely on color to distinguish them from common pigeons. These are: The swallow, helmet, nun, spot, archangel, magpie, quaker, moorcap and others. Fourth, is a breed lacking distinct color or shape, yet possessing the instinct to return home, and an endurance which causes them to rank as fancy pigeons; this is called the Antwerp or homing pigeon.

DESCRIPTION OF SOME COMMON VARIETIES.*

The *carrier* does not, as its name would indicate, carry messages, but is kept as a fancy pigeon, valued only for shape, size and color. It is a large, strongly-built bird with long feathers and a rough appearance; its neck is slim and long, set on the broadest of shoulders. Its beak is at least one and three-quarter inches from the center of the eye; at the base of the beak is the carrier's chief glory, the beak wattle, a bare, fleshy growth in folds; around the eye is a bare circle of skin called the eye cere. The *pouter* is the largest and tallest of the breeds, standing nearly perpendicular on long, slender legs. Its chief peculiarity is an ability while strutting to inflate its breast with air. The *Barbary* or *barb* as it is now called, is one of the oldest of the breeds; it is a strong, large bird with plump body, short legs, broad skull and short beak. It has a large, saddle-shaped beak wattle, with a large, thick, circular, bright-red wattle around each eye. The *short-faced tumbler* is a diminutive bird, sprightly, with broad, well-curved head carried on the slimmest of necks. The beak is so short and fine that many cannot feed their own young, which must be cared for by plebeian pigeon nurses. When a tumbler flies, it turns a very pretty back summersault in the air. Some called *parlor tumblers* cannot fly a yard from the floor, often tumbling within six inches of the floor and alighting on their feet. Others are high flyers, tumbling only occasionally, and are able to remain in the air for hours at a time. The tumblers have the strong homing instinct. The *fantail* has a broad, expanded tail, which may contain as many as fifty feathers. It is a small bird with round body, full breast, the head being carried so far back that it rests against the tail. The points most sought after in the "fans" are small size, large tail evenly balanced, and not carried to one side, and the position of the head far back against the tail. The *jacobine* is a medium-sized, plump bird whose chief peculiarity is a ring of inverted feathers back of the head, which stand up like a feather boa, hiding the head up to the eyes. The *turbit* is a small, round bird, with full breast, short legs and neck. The head is short and round, the beak very short and stout, and the eye large. The feathers on the back of the head are inverted, forming a pointed crest which gives the birds a surprised look. The neck and upper breast have inverted, curled feathers, forming a dainty frill. The *magpie* is a slender, graceful bird with black head, neck, breast and back, and the remainder of the body white. The *homer* or *Antwerp* does not differ in color or form from the common pigeon, but has such powers of flight and such ability in finding its way home, that it is freely accorded a place as a fancy pigeon. Pigeons have been used to convey news since history began and

*The notes on the breeds of pigeons were written for this leaflet by Mr. H. Freeman Button.

probably long before. They were used by all the nations in old times and even now are used in war to carry messages. The training of a homer consists in taking the young bird a short distance from home, say ten or twenty miles, and then liberating it; the next time it is taken forty or fifty miles from home, and thus it is trained in the geography of the home region until it will finally return five hundred or even a thousand miles. It is now believed that pigeons travel mostly by sight, using rivers, lakes and mountains as landmarks.

References.—" The Mourning Dove, Birds of Village and Field," Merriam. " Neighbors with Wings and Fins," Johonnot, Chapter 15. "Arnaux, Chronicle of a Homing Pigeon, Animal Heroes," Thompson Seton. " Squab Raising," Bulletin United States Department of Agriculture. Reading, " Story of Noah and the Dove." " Daddy Darwin's Dovecote," Mrs. Ewing. Journals: *The Squab Bulletin,* 50 cents per year; *The American Fancier,* $1.75 per year. Audubon Educational Leaflets Nos. 2 and 6.

THE ENGLISH SPARROW.

Preliminary Work.—These birds are so common everywhere that they may be studied at almost any time. The pupils should become interested in them in informal talks about the birds. The observations should at first have to do with the appearance and then with the habits of the sparrow.

LESSON LV.

THE ENGLISH SPARROW AS A SPARROW.

Purpose.—To teach the pupils to distinguish this species from our native sparrows and to interest them in sparrows in general.

The first lesson should be in distinguishing between the two sexes of the English sparrow. The male bird has a black spot on the breast, is reddish-brown in color, and has a white bar on each wing. The female is duller in color, no black on the breast and the wing bar less distinct. An observation lesson on the colors of the birds should be made in detail and put in the field note-book. It should give color of crown, back, tail, wings, throat and breast, so as to accustom the pupils to see accurately. When the season admits, this sparrow should be compared carefully in color to the chipping sparrow and the song sparrow.

LESSON LVI.

WINTER HABITS.

Purpose.—To get the pupil to notice how these birds manage to pick up their living in winter.

The observations should be along the following lines: What do they eat and where do they find it? Do they appear in flocks? Where do they

stay nights? Do they live in peace and amity with each other or are they quarrelsome? Do they feed upon the seeds of weeds in winter?

LESSON LVII.

NESTING HABITS.

Purpose.—To call the notice of the pupils to the nests and to the kind of food given to the young.

Compare the nests of the English sparrow to that of the robin, the chippy, the song sparrow or the ground sparrow. Note how slovenly it is built compared with the homes of the other sparrows. Note the color of the eggs and the number in the nest. Note that when the nestlings hatch they are fed largely upon insects. Note how long after hatching before the young sparrows leave the nest, and how long they are fed by the old ones after they leave the nest. Note how many broods there are in a season.

LESSON LVIII.

HISTORY AND ECONOMIC IMPORTANCE OF THE ENGLISH SPARROW.

Purpose.—To make the pupils observe for themselves how the sparrows drive out our native birds and also that their food is largely of grain around barns, and that they do not destroy weed seeds.

After the pupils have made observations of their own along these lines, the teacher may find in the following books and bulletins, facts which will teach further the economic importance of this bird: "Birds in Their Relation to Man," by Weed and Dearborn, p. 144. The following bulletins of the U. S. Department of Agriculture: "English Sparrow in North America;" "Relation of Sparrows to Agriculture," S. D.

Photo. by Verne Morton.

Compare this neat nest of the field sparrow with the slovenly nest of the English sparrow.

Judd, Bulletin 15; "The Food of Nestling Birds," Year-Book, 1900.

Supplementary Reading.—"A Street Troubadour," Lives of the Hunted, Thompson Seton. First Book of Birds, Miller, p. 81. "Blizzard and Three Sparrows That Live in the House," from True Bird Stories, Miller. "The English Sparrow," Forsyth, a poem, Songs of Nature, p. 233.

THE RABBIT.

Preliminary Work.—If the pupils do not have an opportunity for studying pet rabbits outside of the schoolroom there should be one introduced especially for the purpose of the lesson. We know of several schools where a pet rabbit has had the freedom of the schoolroom and has given much pleasure to the pupils. In one instance it was kept in the basement nights, in another in the woodshed. After the pupils have fed the little creature and have come to care for it the lessons may be given as a natural outgrowth of their interest.

LESSON LIX.

PHYSICAL ADAPTATIONS.

Purpose.—To call the pupils' attention to the way the rabbit is fitted to get its food and to escape from its enemies.

The first thing the pupils will note about the rabbit is what and how it eats, because the preparation of its food is a part of the child's duties. This should lead to a discussion of what wild rabbits eat and where they find their food. Note how the rabbit's teeth are fitted for gnawing, through having the two long, gnawing teeth in the front of each jaw. The remaining teeth are broad grinders in the back of the mouth. With all other rodents than the rabbit there are no teeth between the gnawing teeth and the grinding teeth, but the rabbits have a small pair of teeth on each side of the upper long ones. These are left-overs from rabbit ancestors, which evidently had four gnawing teeth on each jaw. It is with these front, gnawing teeth that the rabbit hurts young trees by girdling them in winter, when driven by starvation to feed upon the bark. Note the cleft upper lip which leaves the gnawing teeth free.

In its general appearance the two most noticeable things about a rabbit are its long ears and its long hind legs. These two characters are closely connected; the long ears are always on the move to catch any sound of danger, and as soon as it is heard its direction is determined, and then the long, hind legs are used to help the little creature go in the other direction in mighty leaps. The constantly moving nose probably

also has to do with sniffing danger, for it is only through sure flight that these little animals may escape from the many enemies, which surround them. The rabbits are peculiar also in that the bottoms of their feet are hairy. The front feet cannot be used to hold food to the mouth like squirrel and mice; the pupils should notice that this is not needed as the rabbit eats on the ground. For detailed lesson on the rabbit see "Nature and the Child," Scott, pp. 38-88.

LESSON LX.

THE HABITS OF WILD RABBITS.

Purpose.—To cultivate in the pupils an interest in the habits of our wild species.

First, there should be a discussion of how many species of wild rabbits there are in the locality. In the north-eastern United States there is only one common species and that is the gray rabbit or cotton-tail; the varying hare or white rabbit, which was common here fifty years ago has become practically exterminated. This was one of the most interesting of the species, because it changed its coat to white in the winter. If the pupils are able to study the wild rabbit in nature, let their observations cover the following questions; but if they are so situated that they cannot do this, let them read some of the following stories and answer the questions from what they thus learn: Where does the wild rabbit live? What does it eat? How does it protect itself? Bring out in this the protection which the rabbit gets from its color and also from its habit of "freezing" as well as by running. Describe its runways and "forms." How is the nest built for the young, and how are they protected? How do rabbits show anger or surprise? What are the chief enemies of the rabbit? Describe how the rabbit makes its peculiar tracks, the print of the hind feet always being in advance of the front feet.

Supplementary Reading.—"Raggylug," Thompson Seton "Squirrels and Other Fur Bearers," Burroughs, p. 37. "Rabbit Roads in Watchers in the Woods," Sharpe. "American Animals," Stone & Cram, p. 73. "Familiar Life in Field and Forest," Mathews, p. 263. To point the fact that the rabbit's runways are in the protecting briar patch read the Tar Baby in Uncle Remus stories. "Neighbors with Claws and Hoofs," Johonnot, p. 85. "True Tales of Birds and Beasts," Jordan, p. 83. "Friends in Feathers and Fur," Johonnot, p. 96. "A Bunny Romance," in "The Bashful Earthquake," Hereford. "Little War-horse," in Animal Heroes.

LESSON LXI.

THE VARIETIES OF DOMESTICATED RABBITS AND HARES.

Purpose.—To interest the pupils in the growing of the domesticated varieties and in learning how to give them proper protection, food and care.

Photo. by Verne Morton.

Common domesticated rabbit and young.

Belgian Hare, fawn to red-brown in color, medium size, long and graceful; bred for the market. *Common Rabbit,* which may be white (albino), black, maltese, or with broken colors. *Angora,* white or broken colored; a small to medium breed, with short ears and silky hair; a purely fancy breed. *Lop-eared,* fawn to brown in color; very large ears which droop; a fancy breed; very tender, requiring artificial heat in winter. *Himmalayan,* a small to medium breed; white with black ears, nose and feet; short hair, alert and active; a very fancy breed. *Flemish Giant,* very large, weighing fourteen to eighteen pounds each; fawn to brown in color; seldom raised.

Mr. E. W. Cleeves informs us that he had a Belgian doe which showed her enmity to cats in a most interesting and peculiar way. She would run after any cats that came in sight, butting them like a billy goat. The cats soon learned this foe and would climb a tree as soon as the hare appeared in the vicinity. This hare made a burrow about three feet long, not directly into the earth but parallel with the surface. When she left her little ones she always closed the burrow by making a false bottom of earth, so that any creature coming along would think it had reached the end when really the compartment for the young rabbits was safe beyond. This doe was the mother of 63 young ones in eight months.

THE HORSE.

Preliminary Work.—If any of the pupils have horses that are pets the lessons may begin with stories of them, otherwise begin by reading stories of interesting performance of horses; for instance, such a story as "Kaweah's Run," by King in Johonnot's book, "Neighbors with Claws and Hoofs," or read the stories about the wonderful performing horse in Germany "The Wise Hans." After the interest is thoroughly aroused take up the following lessons in informal talks, getting the pupils to make observations day after day on the horses in the street.

LESSON LXII.

PHYSICAL ADAPTATIONS.

Purpose.—To call attention to the way the form of the horse is fitted for its needs as a wild animal and for the use of man as a domesticated animal.

The most obvious adaptation of the horse is length of legs as compared with body. These long legs enable the horse to run and trot very fast, and thus the wild horse escapes from his special enemies, the wolves; his speed also has made him of the greatest use to man. It would be very interesting for the pupils to learn the different parts of the horse's legs as compared to our limbs. This shows that the horse walks on the nail of one toe, which is called the hoof, and that the heel is the first joint up the leg that we naturally call the knee. Some study should be made of the hoofs of the horse, showing what a perfect protection this one toenail is. Incidental to this study of the horse's legs the fastest running and trotting time may be given. Another noticeable adaptation is the length of the head and of the neck, which seems necessary to enable an animal with so long legs to reach down and crop

the grass while standing. Bring out the fact that the little colt, whose head and neck have not yet reached proper proportions, is obliged to graze with his front legs far apart in order that his mouth may reach the ground. If it is practical, a little study of the horse's teeth should be made; there are six, sharp, broad teeth on each front jaw for cutting herbage; back of these on each side is a long, sharp tooth; behind these is a bare space, then the grinding teeth. Develop the idea that man has taken advantage of this bare space, or bar as it is called, to introduce the bit and thus control this fiery animal. If the lesson is given in the higher grades the pupils should be taught to tell the horse's age by the appearance of the teeth. See *The Horse*, pp. 246, 266. Observations should be made upon the mane and tail of the horse and the use of these attractive features in keeping off flies. For excellent detailed lesson on the horse see "Special Science Methods," McMurray, p. 118.

LESSON LXIII.

HOW A HORSE SHOULD BE TREATED.

Purpose.—To induce the pupils to become interested in the proper care and kind treatment of horses.

When a man is continually whipping or calling out angrily to his horses, we may be very sure he is the poorest kind of horseman; the good horseman uses the whip rarely and then only in time of need. In breaking the horse he thoroughly masters it, and after that depends largely upon his voice for controlling it. Be kind but firm is the rule in dealing with these nervous animals. The bit and the harness should be comfortable. Make the pupils understand how cruel and how unnecessary are collar-galls; if the horse is well-fed and the collar fits this trouble will never occur. The horse requires much care in the stable, the more it is groomed the better it looks. The pupils should become interested in the proper food for the horse; timothy hay, or hay mixed with clover for the bulky food and oats or corn for the concentrated foods form a good mixture. Oats are best adapted to driving horses, but corn may be given to those which are working hard. They should be fed with extreme regularity, and should not be used for a short time after having eaten. Horses kept in cold stables require more food than those in warm quarters; in cold weather it is well to warm the water given to the horses. Induce the pupils to become specially interested in brakes, which help relieve the horse in going down hill, and also in the proper blocking of the wheel to give the horse rest when pulling burdens up hill. The proper bits and the right use of the check reins should be discussed. In connection with this lesson "Black Beauty" should be read.

LESSON LXIV.

THE DIFFERENT BREEDS OF HORSES.

Purpose.—To call attention to the differences in form and in the use of different breeds.

The lesson must come directly within the observation of the pupils and, therefore, it is well for the teacher to find out what thoroughbred horses there may be in the neighborhood and interest the pupils in describing them. If there are any mustangs or western horses in the region, let the pupils compare them with the horses imported from Europe. For help in this lesson as well as in the others consult the volume called "The Horse," by Professor I. P. Roberts; this is a clearly-written, practical book and should be in every school library where there is any interest in agriculture.

Supplementary Reading.—"Cornell-Nature Study Leaflets," p. 589. "Black Beauty." "Animals," Hamerton, p. 57. "Neighbors with Claws and Hoofs," Johonnot, pp. 117-139. "John Brent," by Theodore Winthrop. Excellent and useful information is given in "A Country Reader," Buchanan, p. 1, and in "Agriculture for Beginners," Burkett, Stevens & Hill, p. 183.

References for Lesson on the Horse.—"Special Method in Elementary Science," MacMurray, p. 118. "Nature-Study and Life," Hodge, p. 38. "Nature-Study First Reader," Wilson, p. 118. "Nature-Study by Months," Boyden, p. 48. "Study of Nature," Oakley, pp. 54, 59, 62, 70. "Lessons in Elementary Science," Seamon & Woodhull, p. 58. "Nature-Study," Jackman, p. 137.

THE DONKEY.

Preliminary Work.—If any of the pupils in the locality have a pet donkey, this should be used for study. It should be brought to the grounds, during a recess period two or three times for observation as the lessons progress. It might be well to interest the children particularly in the animal by giving them bits of the history of the species, or by interesting stories like the "Story of a Donkey."

LESSON LXV.

HISTORY OF THE DONKEY.

Purpose.—Through familiar talks and reading to make the pupils realize the part the donkey has played in different civilizations.

The donkey is often spoken of in the Bible, the first mention being in Genesis in the history of Abraham, who found that Pharaoh was possessed of sheep, oxen, asses and camels. To this day the wild asses

still roam in Persia and Armenia as they did in the time when Xenophon described them in the Anabasis four hundred years before the Christian era. These wild asses are very fleet of foot, and have always been hunted by the Persian monarchs. Nadir Shah who lived two hundred years ago, considered the running down of one of these wild creatures with greyhounds as equal to winning a battle or conquering a province; its flesh was regarded as superior to the best venison; its hide was made into Oriental shagreen, a very valuable leather, entirely waterproof. George Washington introduced the donkey to the agriculture of the United States. As it was prohibited to export these animals from Spain, the King of Spain, learning of George Washington's desire, sent him two as a present. The donkey is used extensively to-day in Mexico and the southwest United States, where its endurance as a beast of burden makes it most useful; it is called a burro and one of its chief uses in these dry countries is that of water-carrier, the water being put in goat or sheep skin bags or earthen ollas and hung over the burro's back. Get the pupils to look up "panniers" in the dictionary and note their use with donkeys. The best breeds of donkeys are now found in Smyrna, the Island of Cyprus, Spain and Peru. In Spain they are clipped in fanciful figures, and the gypsies have the monopoly of thus ornamenting them.

LESSON LXVI.

THE DONKEY.

Purpose.—To call attention to the peculiarities of the donkey's appearance.

Notice that its legs are shorter in comparison with its body than are those of a horse; that its head is wider, and that the neck is shorter; the length of the ears is the first feature one notices in the animal. Large ears always mean acuteness of hearing, and when donkeys were in the wild state they had need to hear the approach of their enemies from afar. The arrangement of the teeth is the same as in the horse; the hoof is longer and narrower and more upright than that of a horse and the joint above it, called the pastern, is shorter and stiffer, which renders its feet less likely to become lame; and as the hoof is thicker and therefore tougher than that of the horse it is able to climb mountains and rocky trails where a horse's feet would give out. The tail of the donkey is a tassel, and the mane is not nearly so long as that of the horse. Its coat is shaggy, which enables it to endure the cold better than the short-haired horse. The color of the donkey should be mouse color with a dark line along the backbone, and a dark transverse bar across the shoulders. Compare the whinnying of the horse with the braying of the donkey.

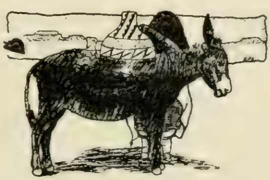
LESSON LXVII.

COMPARATIVE USEFULNESS OF THE DONKEY.

Purpose.—By informal talks and conferences to bring out the special good qualities of the donkey.

The donkey is able to live upon food which would starve a horse. It eats thistles and weeds, and many other things which a horse will not touch. It can subsist on one-fourth the food necessary to keep a horse, and it can carry burdens on its back for long distances, which would break down a horse. It carries these burdens over steep mountains and roads where a horse would stumble and fall. It is the favorite and almost only reliable beast of burden in many cold, mountainous countries, and is quite as useful in the mountains of sub-tropical countries. It is the friend of the poor man because it can pick up its living with little expense. When treated well it is as affectionate as the dog; the mother donkey is exceedingly fond of her colt. The noted obstinacy of the animal comes probably from long generations of bad treatment; it is an assertion of the creature's own dignity which could not be obliterated through thousands of years of abuse. For defense the donkey can both bite and kick, but as a kicker it is most efficient. It can bear its weight upon its front legs and kick with both hind legs with wonderful accuracy and precision, being able to select just the spot where the hoof shall strike.

Supplementary Reading.—"The Story of the Donkey," from the French of the Countess de Segur. "Familiar Animals and Their Wild Kindred," p. 111. "Travels on a Donkey," Stevenson. "Innocents Abroad," Mark Twain, pp. 418, 466. "Aztec Treasure House," Story of El Sabió.



A Burro water-carrier.

ORANGES AND LEMONS.

Preliminary Work.—These fruits, although not seen by the children of our State growing on the trees, are yet almost as familiar to sight and taste as is the apple. The lesson should be begun with interesting geography stories of Florida, California, Italy and the tropics. For pictures of Italy see "Under Sunny Skies," pp. 19-54; for America, "Our Own Country," and "Little Journeys to Mexico." If possible give the children a conception of what an orange grove looks like with its round-headed and thick-foliaged trees, set with fragrant, white blossoms or with green or golden-red fruit.

LESSON LXVIII.

THE FRUIT.

Purpose.—To lead the pupils to see for themselves the seldom noticed peculiarities of these fruits.

First study the fruits entire; observe the differences in shape and color, not only between orange and lemon, but also between the different varieties. Notice the little depressions and pin-like dots over the surface of all the fruits. Shave off a bit of the outer, yellow part of the rind, double it together and pinch it hard; a fine spray flies from it into the air, and a strong fragrance is noticeable. If the spray is made to fall on paper it makes a "grease spot," and if on water drops of oil are visible, but this oil is extremely volatile and soon passes into the air. This oil in the rinds of lemons and oranges is extracted and used for flavoring. The russet color on the Florida oranges is caused by a mite almost invisible, which feeds on the oil. It was formerly confined to Florida but has been introduced from Florida to the lemon groves of southern California; see p. 285, "Yearbook" of the United States Department of Agriculture for 1900.

Note the stem end of the fruit. If there is a button or stub still clinging pick it off; observe that there is a circle of dots beneath it. These are the tips of fibers which held the fruit to the stem; they pass through the fruit from stem to blossom end as may be seen in cross section.

Cut the fruit in cross section and note that the rind is made up of several layers; the outer yellow skin; the layer of oil cells; then a thick white layer next to the pulp. Note that the juicy pulp is divided into radiating sections. Peel an orange and pull apart the sections; note how many there are and the thin membrane which covers them. Break one of these sections and separate one of the cells containing juice and examine it. This is an instance of very large vegetable cell, and may be used to illustrate the cellular structure of all plants, although it should be borne in mind that these cells are developed for juice sacs, while ordinary living vegetable cells contain the growth-making materials of plants. Do the number and size of the sections differ in the lemons and oranges? Does the rind of these two fruits differ in taste as much as does their pulp? Where are the seeds placed? Note the tough skin in which the white, starchy meat of the seed is wrapped. Take a seed apart and discover the germ or sprout; taste the meat of the seed and note how bitter. Might not this bitter taste have been an advantage to the wild orange by causing animals which like the pulp to reject and scatter the seeds? Note that all oranges do not have seeds. This is because man

has been trying to breed them out, because he does not like them in his fruit. The California navel orange is seedless. Note that this orange has another little orange in its blossom end. See "The New Agriculture," Collins.

Plant a few seeds of orange and lemon, labelling them carefully, for the young plants are much alike; these seeds are quite slow of germination and need to be kept steadily warm and moist. A study of the plants, when they come up, will convince the pupils of the near relationship between these species.

BEANS.

Preliminary Work.—If the pupils have gardens and have harvested them, the beans for study should be the product of their labors, for that in itself will make them objects of interest. Otherwise the study may begin by asking the pupils to bring to the school as many kinds of beans as possible, the keynote of interest being a collection of all the kinds of beans. After this let the pupils each have a specimen or two for the study of the bean as a seed. It would be well to soak the beans in water for a day before studying them.

LESSON LXIX.

THE BEAN SEED.

Purpose.—To give the pupils an understanding of the nourishment in the seed for the young plant.

Carefully remove the tough skin from the bean and we find the color is only skin deep, that the thick meat of all the varieties is whitish and firm. Separate the bean into halves just at one side of the "eye" which attaches it to the pod. If the bean is carefully split there will be seen at one end a tiny sprout, or in some instances two tiny, folded leaves. This can be seen with the naked eye, but if looked at with a lens, the folded leaves of this little plant may be easily seen. The use of this lesson should be to get the pupils interested in what happens to all the parts of the seed when it is planted.

In boxes of damp sawdust plant a bean of each kind, labelling each by sticking a toothpick in close to it bearing a tag inscribed with its name. Note that some varieties will appear above the ground far more quickly than others; note the plant first appears as a loop and then pulls its leaves out; note the different colors of the two seed leaves; note that as the true leaves develop the seed leaves shrink, and let the pupils understand that these seed leaves are giving up their meat to nourish the young plant. Note that some of the varieties planted in sawdust or sand will turn yellow and die soon, while others will grow for some time. This shows that there is far more nourishment in the seed leaves of some

of the beans than in others. At the same time these beans were planted in sawdust some should be planted in pots of earth, so that they may grow in the schoolroom window and the plant be studied. Some of those grown in the sawdust may be pulled up at different stages to see what is happening to them.

References.—" First Studies of Plant Life," pp. 12-15; " Plants and Their Children," pp. 96-99; " Cornell Nature-Study," Leaflets, p. 460; United States Department of Agriculture Bulletin 121, Beans, Peas and Other Legumes as Food.

LESSON LXX.

BEAN PLANT.

Preliminary Work.—This should be a study made in September before the beans are harvested, and should be made in connection with gardening.

Purpose.—To familiarize the children with the leaves and the peculiarities of growth of the bean plant.

Pull a plant up by the roots and notice the kind of root and how far it goes into the soil; notice the stems, whether they be rough or smooth; notice that the leaves are borne in such a manner that each leaf is exposed to the sunlight. An interesting fact to note is that the bean leaf is compound, formed of three leaflets. Note the common petiole or leaf-stem of these leaflets which comes off from the main stem; note also that each leaflet has a little stem of its own with stipules. A leaf should be carefully drawn, and if several varieties of beans be studied the differences in their leaves should be noted. If the bean be of a climbing variety, note that it twines, the stem forming a spiral around the support; note if the spiral is always in the same direction.

LESSON LXXI.

THE BEAN FLOWER AND POD.

Purpose.—To make the child familiar with the development of the pod from the flower.

Compare the flower of the bean to that of the sweet pea, Lesson XXVI. Home Nature-Study Course, 1906. In studying the unopened pod note its upper and under seams, and see if they are of the same length. Open the pod and note where the seeds are attached. Notice whether the seam to which the beans are attached opens as easily as the other. Note that the pod is rough outside, and has a smooth, satiny lining, and that you can separate the outer from the inner layer. Let the pod dry and split it, and note whether each side curls in a spiral. Experiment to see whether the beans are thrown out when the pod springs apart.

LESSON LXXII.

SOME COMMON BEAN DISEASES.

Purpose.—To teach the children how to select seed beans, which are healthy.

Perhaps some of the pods and the seeds within them are spotted with dark brown or black blotches; this is anthracnose or pod-spot, although it occurs on leaves and stems as well. This is caused by a fungus, which lives upon the substance of the bean. Beans from spotted pods should never be planted, for although they may grow, they will carry the disease with them to the next generation. Bean-blight is another very bad disease, which ruins whole crops; it is also a fungus, but does not appear as a well defined spot, but looks like a spreading stain that appears blister-like when wet; it is very infectious and all vines thus diseased should be pulled and burned. Beanrust is another fungus which grows upon the leaf but is not so serious as the other two. Early and frequent spraying with fungicides is the preventive of all three. See Cornell and other bulletins on spraying.

NOTES ON BEANS.

The bean is one of the earliest food plants used by man, and in Asiatic and European countries is still much more of a food staple than in the United States. The bean contains more nutriment than any other seed used as food, not excepting wheat and corn. Beans are the main dependence of the armies of the world, as they are the most easily transported and the most economical of foods. New York State leads in the production of beans, putting about two million bushels on the market yearly, though Michigan and northern California are close rivals.

VARIETIES OF BEANS.

The bush beans include all those grown as field beans for the purpose of the harvest of dry shelled seed. They also include the green podded and yellow podded string or wax beans; these are usually grown in truck gardens and very seldom for the shelled seed. The broad bean (*Vicia faba*) is the bean of history. It is a native of southwestern Asia and has been used for food for man and beast for untold ages. It is a large, erect-growing plant, bearing large, flat, roundish or angular seeds; these beans are often ground into a meal. This variety needs a cool climate and a long season, and is not much grown in the United States. In connection with this, ask the pupils to look in the Bible dictionary for *pulse*. The largest of the beans is the Lima, a native of South America; it must have a rich, warm soil, and good support and careful cultivation. The Dutch runner also has large seeds and resembles the Lima in growth. The Scarlet runner, the Hyacinth and the yard-long kinds are all planted in this country for ornament; in other countries they are used as food. The Soy or Soji is a short, erect, bushy, hairy plant, bearing small pods in clusters, which contain little pea-like seeds. It is a native of China and Japan where it is much used for food, but there it is used

mainly for a forage plant, as is the cowpea, which is really a bean. For the common planted varieties, let the pupils study any of the standard seed catalogues. It would be well for the teacher to give a geography lesson on the native lands of these various varieties.

THE PEA.

For this lesson use as a model Lesson XXVI on the sweet pea for the leaves, blossom and fruit. There are not so many species of the pea as of the bean. Besides the sweet pea, there is a perennial or everlasting pea, which is even more beautiful as it bears its blossoms in large clusters, but they are without fragrance. Of the garden peas, one kind, the sugar pea, is eaten pod and all, like string beans. Of the shelling kinds there are two general classes, those with smooth seeds and those with wrinkled seeds, the latter are considered the richer. For varieties let the pupils study any standard seed catalogue.

LESSON LXXIII.

GERMINATION OF THE PEA.

Purpose.—To call to the notice of the pupils the differences in germination of the pea and bean.

Plant a pea in sawdust at the same time the beans are planted. Note this peculiarity: the root grows down from the planted pea and the plant stem grows up. The pea remains in the ground and is not pulled out as is the bean.

LESSON LXXIV.

THE PEA WEEVIL.

Purpose.—To make the children notice the peas containing the weevil, so that they will be able to select better seed.

Other creatures beside people and stock have discovered that peas and beans are good for food; the most important of these is the pea weevil. The mother weevil is a small brown beetle spotted with white, about one-fifth of an inch long, which has a head prolonged into a broad beak; she lays her eggs upon the pod while the peas are quite small. As soon as the little grub hatches from the egg it bores through the pod into the young peas. Here it lives its larval life in its little, round, sweet, meaty world. Before it changes to a pupa it eats a tiny hole in the side of the seed, leaving only a thin scale to push away when it comes out as a beetle. Sometimes these beetles leave the peas during autumn, but as a rule they remain in the seed until spring. In green peas the presence of the weevil may be detected by a little, dark spot on the side of the pea. Seed peas should be placed in water and those that float should be destroyed, for they contain the beetles. It would be a good exercise for the children to plant in pots or in their gardens, some peas which

are infested and some sound peas, and note that though the infested peas may germinate, they will not prove thrifty. The Baltimore oriole has been observed tearing open pea pods and eating the peas, and the ignorant farmer thought he was damaging the pea crop, but experiments have shown that this bird ate only such peas as contained weevils.

References.—" Injurious Insects," Treat, p. 56; Comstock's " Manual for the Study of Insects," p. 581.

THE CARROT.

Preliminary Work.—The carrot is a most convenient plant for winter study, for if it is placed in a pot of soil and kept wet in a warm room, it will soon send out its leaves and be ready for study. A little talk may be given the children about the history of the carrot. It is said to have been taken to England in Queen Elizabeth's time by the Hollanders, who are said to have first cultivated and improved it. From there it was brought to America soon after the landing of the Pilgrims. It was used formerly much more upon the table than at present. It is a most nutritious and when well cooked a delicious vegetable. However, it is now used more largely for stock feeding; all grazing animals are especially fond of it, and the pet rabbits appreciate it highly.

LESSON LXXV.

THE LEAVES.

Purpose.—To call the attention of the child to the peculiarities of the leaves and their growth.

Note the manner in which the leaves spring from the root. Are they grouped in one or more bunches? Pull off one leaf; note its long, slender stem fluted on the under part and grooved on the upper side. Pull a leaf stem apart and note the strong, fiber-like " fiddle strings," which lie underneath the fluted part, and give the stem strength and toughness. Note that the leaves are divided and that the leaflets are also divided. Observe as you pull the leaves off from the root, that although they seem opposite to each other, each one is a little above the other, they are really alternate, but the stem is so short that they are all bunched together.

Let the pupils make a hanging basket of the carrot by cutting off the thick upper end of the root and hollowing it out in cup-shape, leaving a shell about half an inch thick; hang this in the window bottomside up and keep it filled with water, or with a sponge kept wet, on which grass seed is sown. Soon the carrot leaves will grow and turning upward cover the basket. After a time the leaves will turn yellow and droop and the pupils should understand the reason for this is that all of the food of the carrot root has been used up and the leaves have no further means of nourishment.

LESSON LXXVI.

THE CARROT TUBER.

Purpose.—To interest the children in the way the carrot stores food to help it develop its seed.

Material.—One of the roots entire, one cut in lengthwise sections and another in crosswise sections. First note the beautiful orange color which shows plainly through the thin skin which covers the root. Note the fine thread-like roots, which fringe all sides and reach out from the tip. These are the working roots, reaching out into the soil for moisture and nourishment. Note in the sections of the root, the more fibrous central part is separated from the orange outer section by a line of lighter color. Note that wherever a rootlet is given off there is a pin-like fiber which extends to the center of the root. This whole edible part of the carrot is properly called a crown tuber instead of a root because from the top of it on its crown the leaves grow.

After this lesson has been given, the story of the plant should be told, how that it starts from the seed one year, but does not blossom and perfect seed until a year from the fall after it is planted. Therefore, it must have some way of passing the winter, and it stores up during the first season a large amount of food in this crown tuber storehouse and thus remains safely in the ground all winter. As soon as spring opens the leaves start fresh from the crown early in the season, and the energy of the plant is not wasted by searching for more food, but is devoted to the development of the flowers and the seeds. Call attention to the fact that what is food for the plant in this case is also food for us. If a carrot be planted in a pot the pupils will see that the stored food disappears, what was the fleshy root becoming shrunken, as the leaves develop.

References.—For detailed lesson see "Nature-Study with Common Things," p. 107; "Botany," L. H. Bailey, Chapter 6.

THE TURNIP.

Preliminary Work.—The turnip is also a crown tuber and its food is developed and stored in a similar manner to that of the carrot. If a small one be potted and given light and water it will, in a few weeks, send up a crown of leaves and be quite decorative and an interesting object to study. It would be well to study this at the same time that the carrot and beet are being studied, and make special point of the fact that in the same garden with the same soil, nourishment, sunlight and air that the carrot stores up orange food, the beet stores up red food and the turnip white or yellowish food. This fact should be used to impress the pupils with the individuality of plant species, each plant being able to take the same materials and color them so differently. The lesson on the turnip should follow the lines suggested in the carrot lesson.

LESSON LXXVII.

VARIETIES OF TURNIPS.

Purpose.—To call the attention of the pupils to the kinds of turnips in the market or grown in their own neighborhood.

In general, two kinds of turnips are grown by the farmers in New York, the flat turnip and the rutabaga, the latter called the Swedish turnip. It would be a good plan to secure specimens of both and observe their likenesses and differences. In shape the rutabaga is elongated and rigid with roots springing from all sides of the tuber as well as from the long, pointed tap-root. The flat turnip is a flattened sphere, smooth, and the fine rootlets are nearly all confined to the tap-root.

Photo. by Verne Morton.

The Rutabaga. A good provider.

The rutabaga leaves are large, smooth, blue-green without hairs, thick and cabbage-like. The flat turnip has leaves that are thinner, narrower, more deeply scalloped and are green and hairy. In size the rutabaga may be from six inches to a foot in length and often weighs several pounds. The flat turnip seldom grows large enough to be an unwieldy handful. In quality the rutabaga is firmer, richer, sweeter, though coarser-grained than the flat turnip, but it is late, requiring all the season to grow, and is available only for fall and winter use; while the flat turnip may be used in early summer and two crops are grown on the same ground. Although the turnips will live in the ground all winter, and send up their leaves and blossoms the next spring, yet those who grow turnip seed in this climate take up the tubers and store them, carefully covered with earth or sand, so that they will wither as little as possible and then replant them in the spring; more and better seed is thus obtained.

Turnips have several insect enemies. The cabbage butterflies lay their eggs on the rutabaga leaves almost as freely as on the cabbage; the leaves of the flat turnip are often riddled by the flea beetle. The worst enemy is the root maggot, which is the larva of a fly, and it burrows deeply into the tuber, spoiling it for household use. This is the same pest which attacks the radish. *References.*—"Injurious Insects," p. 35, 110, United States Entomological Bulletins.

THE GERANIUM.

Preliminary Work.—This flower will grow for every one, and is much loved because of its bright blossoms. At any season of the year it is possible to have the flowers for study. The single varieties are best for this purpose. No outside help is needed in getting the children interested in this plant; if it grows in the schoolhouse windows or on the grounds the interest will be already created.

LESSON LXXVIII.

THE GERANIUM PLANT.

Purpose.—To cultivate in the pupils the habit of closer observation of this common plant.

Note that the stem is thick and fleshy; there is food stored in these stems, which accounts for the readiness with which cuttings will grow. Notice the stipules where the leaves start from the stem and that these remain after the leaf has fallen. The leaves should be drawn, as they offer excellent material for a careful drawing lesson; they are of various shapes although of one general pattern. Some of them show the dark horseshoe mark, which gives the name "horse-shoe" geranium. The first thing to note about the flower is that there are many flowers growing together in one head. Note especially how much more showy are the flowers thus arranged than if they were scattered over the plant. Note how many flowers there are in one head. It is well to begin to study the blossom when it is still in the bud. Note that the buds droop; note that the bud at the center rises first and blossoms. Let the pupils keep a calendar, stating each day how many there are in blossom, whether the central or outside blossom blooms first, whether some of the blossoms are faded before the last one opens. In studying the single flower note the five sepals and five petals, while the double ones have many petals. Note that the anthers are five in number, and that the top of the pistil is five-parted, each division curling back, making it a most exquisite object to look at through a lens. The geranium has been cultivated so long by cuttings that it seldom produces any seed. It would be well to say something to the pupils about these plants, which have depended upon man so long for their planting, multiplying and distribution that they do not raise any more seeds for themselves.

LESSON LXXIX.

HOW TO MAKE CUTTINGS FROM GERANIUMS.

Purpose.—To familiarize the children with the best way to make the cuttings and start them growing.

The smaller side branches or the tip of the main stem, if the plant shows a tendency to grow too tall, may be used as cuttings. With a sharp knife make a cut straight across. Fill shallow boxes with sand, which is kept damp, and place them in a cool room. Plant the cuttings in these boxes, putting the stem one-third its length into the sand. After about a month the plants maly be repotted in fertile soil. The fall is the best time to make the cuttings. (See Cornell N. S. Vol. p. 370.)

THE BALSAM FIR.

Preliminary Work.—This tree is a native of Canada and the northern United States; it has been quite extensively planted as a shade tree around farm houses, and in village yards and parks. It is a tall, slender, and almost black pyramid; its lower branches are likely to lose their leaves and look very untidy unless trimmed off.

LESSON LXXX.

STORY OF THE BALSAM FIR.

Purpose.—Through an informal talk to give the pupils an interest in this tree and the regions where it is native.

Balsam fir.

Its range is from Labrador through Canada and New England to Minnesota and south along the mountains of Virginia. Let the pupils draw a map of this region outlined. The balsam grows on mountains at an altitude, often of five thousand feet. It also flourishes in alluvial or swampy soil. Its leaves are very fragrant and its fragrance is healthful; for this reason the leaves are stripped off the boughs to fill pillows; so health giving is its aroma that it is often called " Balm of Gilead fir." Woodsmen also prefer the balsam branches for making their beds in camps;

for the way these beds are made see "Two Little Savages," p. 256. The balsam fir is also first choice for Christmas trees; in connection with this read Anderson's "Tannenbaum." A peculiarity of the balsam tree is that especially when young, blisters filled with resin form on its bark; when these blisters are punctured a beautiful, clear gum, known as Canada balsam flows out, about the consistency of mucilage and as clear as water, which hardens on exposure to the air and becomes amber in color. It should be explained that resin is not sap of evergreen trees, but is a secretion that serves the tree well by covering wounds, thus keeping out the spores of fungi. This Canada balsam is used the world over for the mounting of microscopic specimens; it is also used in medicine. In connection with this let the pupils look up in the cyclopedias the story of amber.

The wood of the balsam fir is weak, coarse and not durable. It is used chiefly for making boxes. From the bark is distilled "the oil of fir."

Supplementary Reading.—"In the Maine Woods," Thoreau. "Adirondack Sketches," Charles Dudley Warner. "Sam Lovell's Camps," Rowland Robinson.

LESSON LXXXI.

THE FOLIAGE AND FRUIT OF THE BALSAM.

Purpose.—To enable the pupils to identify the tree, and understand the way its seeds are grown and planted.

Material.—Branches and cones of the balsam fir, and if possible branches of hemlock and spruce.

The leaves are three-quarters of an inch in length or less and are very blunt at the ends. They are olive-green above and whitish below; they may be told from the leaves of the hemlock because they set directly on the branch, and have no little leaf-stems as do hemlock leaves; note that in cross section the leaf is flat, and it has a suture above and a corresponding ridge below. Note that there are apparently more leaves on the upper side of the branches than below; see whether this is really true, or whether the way the leaves are twisted toward the light make it seem so. After the leaves are studied, note if the twigs stand opposite each other on the branch. Note at the tip of the branches that the buds in winter look as if they were varnished. One of the characteristics of the tree is that the cones stand upright. They are purplish in color, blunt and oblong from two to four inches long. Note that the cone scales are wide with the edges entire and that the little pointed bract, not as long as the cone scale, is just below each scale. Note how many seeds are beneath each scale. The cone, the cone scale, bract and seed should be sketched.

References.—"The Tree Book," Rogers. "Our Native Trees," Keeler. "A Guide to the Trees," Lounsberry. "Familiar Trees," Mathews. "First Book of Forestry," Roth. "Cornell Nature-Study," Leaflet p. 333.

THE NORWAY SPRUCE.

Preliminary Work.—This particular spruce is selected because it is grown everywhere in our State as an ornamental tree. However, in those schools situated in the Adirondack region, a study should be made of our native spruces. The study of the Norway spruce may well begin with a geography lesson on the Norway spruce by reading from geography readers "Northern Europe," p. 11; "Modern Europe," chapter V; H. H. Boysen's "Stories of Norse Life." In the reading or the talks about Norway emphasize the fact that heavy snows cover the lands in winter.

Norway spruce.

LESSON LXXXII.

THE TREE.

Purpose.—To call attention to the peculiarities of the tree so that it may be recognized at a glance.

A sketch should be made of the tree if possible, paying especial attention to its outline, and the angle at which the branches come off the trunk. Note that it is a pyramid with a central stem, that the angle between the lower branches and the trunk is much wider than between the upper branches and the trunk. Note especially the peculiar way the twigs droop on each side of the lower branches. By suggestion make the pupils see that this peculiarity is a device for shedding snow. Snow is one of the enemies of evergreens since it breaks their branches, and if a tree is native to a snowy country it will succeed better if it sheds the snow. Note that unless a spruce tree has been trimmed its lower branches sweep the ground; this is a point of beauty.

LESSON LXXXIII.

LEAVES AND FRUIT.

Purpose.—To make the pupil observe the foliage and fruit in detail.

Note that the leaves are longer and sharper than those of the balsam. Let each pupil take a leaf and by turning it slowly and letting the light strike across it, it will be seen to have four sides. Cut the leaf across and note that it is diamond-shape in cross section. Take a branch and by passing the hand over it from tip toward base feel the sharpness of the leaves. In studying a branch note how far each terminal twig grew last season; the remnant of last year's bud will mark the place. Note that the buds in winter look like little, brown flowers, and that they are not varnished like the balsam buds.

In studying the cone note first its shape and measure its length; if possible have the pupils sketch it. Note that each scale has a little notch at its outer tip; tear off a scale and let each pupil have one for studying and drawing. Put the cone in a dry place in a pasteboard box and let the pupils see it open and note where the seeds lie; let each one sketch a seed.

NOTES ON SPRUCE.

We have three native species of spruce, all of which may be found in the mountain districts of northern New York. These are called the white, the red and the black spruce. Lumbermen consider the black and red identical but botanists separate them; the black spruce has dark bluish-green foliage and it retains its cones for many years, so that it has a shaggy, rough appearance. The red spruce has yellowish-green foliage and sheds its cones yearly. The wood of both these species is used for interior finishing and flooring, and especially for pulp for making paper. Spruce beer is made by boiling young branches in water and adding to it molasses and yeast; chewing gum is made from resin which exudes from the tree. The white spruce has light, pea-green foliage; the leaves when crushed give off a very disagreeable odor. The cones are shed as soon as the seeds are scattered, its wood is especially used for paper pulp.—(See books mentioned in study of Balsam fir).

MOTHERHOOD OF PLANTS.

JOHN W. SPENCER.

When we become chums with plants their impulse for motherhood is plain to see as the nose on one's face. I do not make this statement as a simile but as a clear cut fact. Plants vary in their methods of motherhood and all are good mothers, too. We see something similar in our domestic animals.

LESSON LXXXIV.

Purpose.—To call the pupil's attention to the motherhood of animals and birds. (As a preparation for the following lessons.)

Observation lesson for pupils.—The care the cat gives her kittens. The cow's care of the calf. The devotion of the mother bird to her nestlings. Reading lessons on the devotion of animals and birds to their young.

One of my early financial enterprises was that of buying thirteen duck eggs and borrowing a sitting hen. When she had hatched the ducks her usefulness as a mother had passed and I returned her to her owner with thanks. She loved those little ducks, but her method of step-motherhood was not adapted to their waddling ways and habit of walking one side at a time. They loved the water after the manner of mermaids, while a few drops filled the hen's conceptions of necessary needs. I have never known ducks to be used in hatching chickens, but the result may be easily conceived. The young chickens could never adapt themselves to the point of view and habits of life of a mother having a flat bill and web feet.

LESSON LXXXV.

Purpose.—To lead the children to understand that plants also have the instinct for motherhood, although it is shown in a different way from motherhood in animals.

Observation lesson.—Count all the seeds in one burdock bur, multiply this by the number of burs on the plant, to show the number of seeds the mother plant tried to scatter abroad.

Although plants never have brawls, yet the competition among them in gaining possession of all the real estate in sight is very strong. The plan of conquest is to send seeds afield and occupy the soil on the principle of "squatter sovereignty." The theory is the same as that of Napoleon, that success is on the side of the largest battalions. It is by

means of prolific motherhood that the plant battalions are maintained. The different methods of motherhood comport with the habits of life and environment of the plants and vary as widely as those of hens and ducks. We have cold-loving plants, corresponding to the polar bear, and warmth-loving plants, corresponding to the monkey. We have the sedges that thrive in wet places, like the beaver; the cactus that is most comfortable when located in a desert, as are the lizards. There are social cliques among the plants as exclusive as are the people who live on the avenue. Each plant clings tenaciously to life and by its own peculiar method of motherhood propagates its family, and tries to exclude all rival plants. I may say that the motherhood is aggressive,—it has to be or lose ground. Other plants having aggressiveness leave no place for the plant of shiftless and half-hearted purpose.

A boy's laboratory. Testing for starch with iodine.

In the thrifty soil of my well tilled meadow there is no place for white daisies. Later, when the constitution of the grass becomes impaired and its luxuriousness declines, leaving patches of bare soil, the daisy finds its opportunity to get a foothold. As the grass continues to decline, the population of the daisy increases. It is commonly said that the weeds "run out the grass," but such is a mistaken idea. When by reason of declining vitality the grass vacates the sod, the weeds come in as new tenants. If I invigorate my meadow by tillage and fertilizers the daisy will disappear and the grass be the sole possessor.

Understand, please, that there is competition among different kinds of plants just as there is in the business world to secure trade.

LESSON LXXXVI.

Purpose.—To let the pupil see that one of the ways that weeds take possession of the land is through this instinct of motherhood, i. e., scattering many seeds.

Observation lesson.—In the garden we plant our seeds in rows, yet more plants appear between the rows than in them. All these between the rows were planted by the mother weeds of last year.

Plants without a navy will cross the sea, invade a foreign country and carry on battles of conquest. A larger part of the plants we call weeds—plants whose possession of the soil is contested by the hands of the husbandman, are foreigners. These plants mostly come on ships as stowaways, land by stealth like felons, and begin their crusade, which rarely ends in failure. When once they gain a foothold on perhaps a thimbleful of soil, though they are without feet, they march across a continent, over mountains and across lakes, like an army of invasion.

Their methods of transportation are by no means uniform. Some weed mothers send their offspring on the wings of the wind. Others seek conveyance by tides and streams. Some by hooked fangs fasten their seeds to the clothing of men and the hair of animals. Some have subway stems or roots and others shoot the seed some distance away, chancing accidental means to carry them farther on. The limit of this lesson does not permit giving the details, showing the many cunning devices whereby these journeys are accomplished.

Reference.—" Seed Dispersal," Beal.

LESSON LXXXVII.

Purpose.—To call attention of the children to the fact that animal life is dependent on plant life.

Observation lesson.—Let the pupils think for themselves that though we eat beef or mutton, the cattle and sheep live on plants. Birds eat insects, but the insects live on leaves or other parts of plants.

Plants are the only living things that secure food from inorganic matter. Were it not for this power of plants we should all perish from starvation. The food of all animal life, from midget flies to elephants, depends directly or indirectly on the food made by vegetable growths having green leaves.

LESSON LXXXVIII.

Purpose.—To cause the pupils to think of the leaves of plants as factories in which starch is made, and that these factories are run by sunshine power.

Observation lesson.—Study the house plants in the window and note how all the leaves turn toward the light. Take two equally thrifty plants out-of-doors or in the schoolroom window. Water and care for them both alike, but from one keep all the leaves trimmed off. It will die because it has no starch factories to manufacture food for it.

We now come to another point which I hope will greatly interest you: How is the food upon which all life depends made by plants? I think no scientist will deny me the privilege of saying that it is all made

in factories. Very busy factories they are, and silent ones. They are mainly in the leaves of plants. The leaves must be green and of a very healthy growth or the factories will get out of repair. Some of the raw material that is used comes from the soil, but more of it comes from the air.

The power to run the factories comes from the sunbeams.—You are all familiar with the sight of house plants bent toward the window. That is because they are reaching out to get the power in the sunbeams to run the factories in their leaves. The power in the sunbeams is greatest in the summer when the freckles come on faces and tan on bare feet. In winter, even though the moisture and temperature of the greenhouse are made just right, the starch factories are not so active as in summer. The shorter and cloudier days afford part of the reason and the glancing of the sun's rays is another and greater one. The teacher who has studied physical geography may explain to her pupils why the rays of light become more vertical—more up and down—as the days become longer.

LESSON LXXXIX.

Purpose.—To interest the pupils in starch as a plant product and as a food for man.

Experiment.—The iodine test for starch in potato, corn, etc. For suggestions on this lesson see "First Studies in Plant Life," pp. 109-120. Chapter XII in "The Great World's Farm."

The boy professor. Now adds fourteen parts water.

The products of the factories are mostly starch. All the starch the world has ever known has been made by plants. The greatest chemist who ever lived could not make enough starch to stiffen his own shirt collar, yet every summer tons and tons of it are made by the busy plants all about us.

All the life in the world depends on starch. It is the foundation food. When in the plant it is capable of going through a number of changes, much as water can change to vapor, steam, now, ice,—but to a chemist, whatever the change or form may be, it is always water. The starch grains which are made

in the green parts of the plant can take on changes and travel to all parts of its body and change back to starch grains and rest there until the starch is needed to enter the growth of some of the many parts, such as new twigs, new roots, flowers or fruits and particularly seeds.

All thrifty trees—fruit trees, we will say—may have more starch than is needed for the time being and it is held for future use, much as a prudent man will put money into the savings bank for a time of need.

If you wish to see with your own eyes the grains of starch which the plant has stored away for future use, you can do so by using what is called the iodine test. It is a simple experiment and the teacher may be kind enough to help the pupil in doing it: Into a small bottle put a few drops of tincture of iodine and add fifteen times as much water as the quantity of the tincture. Keep the bottle corked when not in use. On a thin slice of potato put a small drop of diluted iodine, no more than will stick to the tip of a tooth pick or broom splint. Instantly you will see a purple or purplish-brown stain. Under a lens, even of very low power, the stain shows as a collection of purple specks. Those are starch grains which the iodine has colored. The starch grains in a potato are important factors that make it so valuable as a food.

LESSON XC.

Purpose.—To show that plant-food is stored in the branches of trees in winter.

Experiment.—In March have the pupils cut twigs from willows, lilac or apple and place them in a bottle of water and let them watch the leaves develop.

The willows are among the first shrubs to awaken in the spring. Cut some long twigs and put them in a bottle of water. After a short time the buds will enlarge and then the leaves will put out and a shoot will show a little growth. All this growth requires substance, which comes from the starch that was stored in the twig the season before. The water in the bottle enables the starch to take a form so as to be available for making growth, but water alone cannot give that growth.

LESSON XCI.

Purpose.—To cause the pupils to think why fodder and grass should be cut before ripe.

Observation lesson.—In haying time let the pupils in rural districts find out by questioning their fathers the fact that hay to be good should be cut before it is entirely ripe.

The elaboration of this lunch of starch is the most strenuous time in the history of the plant. A stalk of growing corn is a common example. Before the formation of the kernels the stalk when cut and cured makes acceptable fodder. After the kernels have matured, that is the lunch of starch fully elaborated and placed next the embryo, the ear has more nutrition than the stalk, and the stalk is less valuable for fodder than before the maturing of the ear.

The good farmer cuts his grass before the seed has fully matured. The food when in the blade and stalk, is more available for animal digestion than when stored in the fine grass seeds.

LESSON XCII.

Purpose.—To lead the child to think why fruit should be thinned on overloaded trees.

Observation lesson.—Notice that a tree overloaded with apples one year bears none or few the next.

Should the orchardist permit his peach tree to overbear, the mother tree will give her last energies in perfecting a lunch and protection for the embryo in each pit and becomes exhausted and unable sufficiently to develop the fleshy part of the fruit wherein lies the commercial value to the orchardist. A man of experience will thin the fruit one-half or three-quarters as he would depopulate an overcrowded orphan asylum, thereby fitting the demands required of the tree to its capabilities. A tree debilitated by overwork of motherhood cannot be depended on for a full crop another year, and furthermore is more liable to disease when thus overworked. In breeding new varieties of any of the stone fruits those having the smallest pits have a strong merit in their favor. This principle of seed exhaustion is very strikingly shown in the frequent cutting of flowers to cause the plants to continue to bloom.

LESSON XCIII.

Purpose.—To give the pupil an understanding of the reason that cutting of flowers enables the plant to continue in blossom for a long period.

Experiment in gardening.—Two pansy plants in flower; other plants will answer the purpose. Let the flowers on one mature; keep the flowers of the other cut, and note which yields the most blossoms, and which blossoms for the longer period.

This principle may be markedly illustrated in sweet peas and pansies and nasturtiums. For a test let some plants of the above kinds retain all the blossoms and form seeds and from the remaining plants pick all

the flowers as fast as they open. The plants that perfect the seed will show decline sooner than the ones that do not. The one who is generous with his flowers will get better ones and more of them besides knowing the blessedness of giving.

I have been speaking of self-sacrifice, and the great expense of energy on the part of the mother plant in giving its offspring, the embryo, the proper lunches to carry each through infancy into a period of youth when the youngster will have all the necessary machinery to make its own living. I will now speak of the prodigal profusion with which she produces embryos.

LESSON XCIV.

Purpose.—To give the pupils a comprehension of what would happen if all the seeds of any one plant should find free place for growth.

Observation lesson.—Count all the seeds in one dandelion head. Measure the space covered by one dandelion plant, multiply and see how much space would be covered if every seed from one plant should grow and mature.

If all the seed that one thrifty maple produces during its lifetime, stretching over a number of years, were to grow, how large a forest do you fancy that mother could contemplate, supposing the tree were gifted with thoughts? Again, fancy that all those trees in that maple forest were to produce seeds and each seed was to be wafted to unoccupied soil favorable to its growth, how immense would be this second forest? Let the process continue, with the third forest and so on; how long would it be that a continent would be necessary to hold the entire number of maple trees? This picture seems to fulfill the impulse of plants. Each works to become a monopoly and occupy the earth with its own race. The goal of one kind of plants is the goal to which other plants are also striving, so we have one monopolist competing with others. In the millions of seeds sent forth by the maples of a neighborhood, millions fail. When you behold a stately maple, think of it as the survivor of tens of thousands of seeds that left the mother plant for the same career, but failed. I think of a plant as having the impulse of a trust to be the sole occupant of the soil but is held in check by the competition of other trusts.

LESSON XCV.

Purpose.—To make the pupils think why we hoe weeds in the garden.

Observation lesson.—Any weedy garden will afford an object lesson in the fact that weeds in plenty retard the growth of the planted crop, even if they do not choke it out altogether.

When I am working in the garden I fancy I am a "trust buster," to use a colloquialism of the present hour, in that I am working in the interests of the weaker plants by destroying the stronger ones we call weeds.

When I see a cultivated crop in a swamp of weeds I realize that the former unaided, cannot meet the competition of the latter as opposing monopolists. "Why is it that one variety of plant is capable of robust growth and able to gain an occupation in the soil over others?" Often when such is the case we call the stronger plants weeds. I might be able to answer your question if I were able to give you a clear reason why a goat will thrive under conditions where a fine blooded sheep will starve.

Every summer I raise a patch of carrots for my old horse, Tom, and that, too, at the expense of much backache. I get another backache in the extermination of the wild carrots out in the meadow and along the dusty roadside.

This latter is the progenitor of the garden carrot. I find myself working about as hard to promote the growth of one as I am in the extermination of the other. For utilitarian purposes the garden carrot has by plant breeding been developed into an abnormal plant and stands in the place of the sheep, while its foremother represents the goat.

The test. Watch the starch grains change in color.

As the number of leaflets issued is necessarily limited, the editors ask that the teachers who wish to have the leaflets for the year will communicate with them every month. These communications may be either of the following:

First, writing out in full the subject-matter of any five of the following lessons, supplementing the information given by personal observations. Second, giving the experience of the teacher in presenting five of the lessons to the pupils of any grade.

At the end of the year a statement certifying to the fact will be given to each pupil in the Home Nature-Study class who has accomplished the work of the year satisfactorily.

Address all communications to the editors.

"I dislike to hear people say that they love flowers. They should love plants; then they have a deeper hold on nature. Intellectual interest should go deeper than mere shape or color. Teachers or parents ask the child to see how 'pretty' the object is; but in most cases the child wants to know how it lives and what it does."

"In the early years we are not to teach nature as science, we are not to teach it primarily for method or for drill; we are to teach it for living and for loving—and this is nature-study. On these points I make no compromise."

"If one is to be happy, he must be in sympathy with common things. He must live in harmony with his environment. One cannot be happy yonder nor to-morrow: he is happy here and now, or never. Our stock of knowledge of common things should be great. Few of us can travel. We must know the things at home."

"Nature-love tends towards naturalness, and toward simplicity of living. It tends countryward. One word from the fields is worth two from the city. 'God made the country.'"

L. H. BAILEY.

Home Nature-Study Course

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BOOKS REFERRED TO.

"Field Book of Wild Birds and Their Music," Mathews.

"Second Book of Birds," Miller. "True Bird Stories," Miller.

"Bird Life," Chapman. "Bird Neighbors," Blanchan.

"Birds of Village and Field," Merriam.

"Birds that Hunt and are Hunted," Blanchan.

"Guide to the Birds of New England," Hoffmann.

"Birds of Eastern North America," Chapman. "Citizen Bird," Wright.

"Story of the Birds," Baskett. "The Bird Book," Eckstorm.

"Kindred of the Wild," Roberts. "Familiar Life in Field and Forest," Mathews.

"Northern Trails," Long. "Wilderness Ways," Long.

"Watchers of the Trails," Roberts. Heart of Oak Books.

"Prairie Dog Village," Washington Irving. "Claws and Hoofs," Johonnot.

"Secrets of the Woods," Long. "Wild Life of Orchard and Field," Ingersol.

"Wild Neighbors," Ingersol. "Wild Life near Home," Sharp.

"Lives of the Hunted," Thompson Seton. "The Life of Animals," Ingersol.

Stories of brave dogs from *St. Nicholas*.

"Rab and his Friends," Brown. "Animal Heroes," Thompson Seton.

"True Tales of Birds and Beasts," Jordan. "American Animals," Stone & Cram.

"Little Beasts of Field and Wood," Cram.

"Squirrels and Other Fur Bearers," Burroughs.

"Ways of Wood Folk," Long. "Wild Animals I have Known," Seton.

"Familiar Life in Field and Forest," Mathews.

"Nights with Uncle Remus," Harris.

Cornell Nature-Study Leaflet, Vol. II, No. 3. Cornell Leaflets.

"Moths and Butterflies," Dickerson.

"Caterpillars and Their Moths," Elliott and Soule.

"Moths and Butterflies," Ballard. "The Tree Book," Rogers.

"Our Northern Shrubs," Keeler. "Our Native Trees," Keeler.

"Everyday Butterflies," Scudder. "Insect Life," Comstock.

"Outdoor Studies," Needham. "Ways of the Six-Footed," Comstock.

"Manual for the Study of Insects," Comstock.

"How to Know the Butterflies," Comstock.

"The Great World's Farm," Selina Gaye.

"Wolves," Bailey, Bulletin 72, Forest Service, U. S. Dept. of Agr.

Audubon Educational Leaflets No.'s 11, 12, 17.

Junior Audubon Leaflets.

HOME NATURE-STUDY COURSE

TEACHERS' LEAFLET

BASED ON THE WORK FOR FIRST AND SECOND YEAR PUPILS AS OUTLINED IN THE SYLLABUS OF NATURE-STUDY AND AGRICULTURE, ISSUED BY THE NEW YORK STATE EDUCATION DEPARTMENT.

When the teacher is preparing herself for giving a nature-study lesson, even though it be to the youngest pupils, she should learn all she can about the subject. Not that she will need to use all the material which she will naturally gather for her own edification, but she should have it well assimilated in her own mind as a background against which she can bring into high light those points of interest which she chooses for her pupils. This is the only way she can be sure of herself or her work; and it is with this fact in view that the editors have written this leaflet.

The editors are under obligations to Miss Ada Georgia for her very practical assistance in preparing this leaflet.

THE CANARY AND THE GOLDFINCH.

Preliminary Work.—As a rule teachers have not realized what a valuable help the canary affords for beginning bird study. A canary rightly observed will give the proper methods for observation of birds out-of-doors. The work on the canary should be related from first to last to the story of our common goldfinch, with which all children in the country are familiar. It is necessary for the study of the canary that at least one bird, and better still a pair, should be in a cage in the schoolroom. If this is impossible, the observations may be made upon canaries kept by the pupils at home. The questions in the succeeding lesson should be given, one or two at a time, and a day or two apart, so that the pupils will have opportunity to think and observe; above all they should never realize that they are having a nature-study lesson.

LESSON XCVI.

OBSERVATIONS ON THE CANARY.

Purpose.—To make the pupils relate what the canary is with what it does.

Begin with the obvious adaptations for procuring food. What does the canary eat? Seeds, crackers, hard-boiled eggs, dry bread and cuttlefish bone. What kind of plants are the seeds borne on which we buy for the canary? The goldfinch feeds upon seeds of thistle, wild grass,

ragweed, beggar ticks, sunflower seeds, etc. The goldfinches are of great benefit to us by destroying a vast amount of weed seed in fall and winter, thus keeping it from growing the next spring. Note how the canary prepares its seeds for eating, that however fine they are it shells them with its wide, sharp beak. Note that the beak is not long, like the robin's, which is fitted for eating insects, but it is broader and stronger, fitted for cracking seeds. Note how the canary takes off pieces of cuttlebone; if its beak were not so strong it could not remove bits of this hard substance. Note how the bird drinks, by lifting the head and letting gravity do the work of getting the water down the throat. Note where the nostrils are. Note the way the canary looks at anything, first one side and then the other; bring out the idea that its eyes are at the side of the head, so that it can see backward as well as in front. Note when it becomes drowsy how its eyes close with a little inner lid. Note that its legs and feet are covered with a little armor of protecting scales. Describe the toes and compare the length of the nail with the toe and see how the feet with the nails are fitted for grasping instead of walking on the ground. Show that the goldfinch has little need to be on the ground, but is always on some swaying weed-top or twig. Note especially how the toes are arranged when the canary is on its perch. Is the toe behind larger because it needs to be strong enough to balance the three toes in front? Does the canary walk or hop on the bottom of the cage? Describe the color of the plumage of the head, back, tail, wings, breast and lower parts. Are the sexes of the same color? Note that in case of the goldfinches the male is yellow with black wings; the female is dull, olive green. In the winter the father goldfinch changes his color to resemble his mate. A good exercise in close observation is to get the pupils interested in counting the number of tail feathers and wing feathers on the canary.

LESSON XCVII.

THE HABITS OF THE CANARY

Purpose.—To cause the pupils to observe more closely the habits of the canary.

If there are two birds in the cage, are they always pleasant to each other? How do they show displeasure and bad temper? How many notes does the canary have, which we can understand? There is the cheerful "pweep," which means all is well, the joyous greeting when the friend who feeds it comes into the room, the long, disconsolate "peep" that comes from loneliness or hunger and thirst, and a quick little cry of fear. The father bird has besides these his beautiful song. Note that the bird when singing is likely to lift his beak and throw his head back,

just the way that an opera singer throws his head back to give full power to a note. Note if all canaries sing alike. Describe the canary when asleep; how it sits on the perch with feathers down over its feet and head under the wing. The goldfinch has the same beautiful, reedy note, which characterizes the canary. Get the pupils interested in watching the goldfinches fly; see " Hand Book of Birds," Chapman, p. 287.

LESSON XCVIII.

THE NEST AND YOUNG.

Purpose.—To make the pupils interested in observing the nesting habits of the canary.

When canaries get ready to make a nest we put a box in the cage and give them cotton, wool and string; they are likely to strip the paper from the bottom of the cage for nest material. Note if the father bird helps in making the nest. Note how often the eggs are laid. Describe the egg carefully, giving the approximate size and color. Does the father bird help sit on the eggs? Does he feed the mother bird when she is sitting? How long after the eggs are laid before the young hatch? Do both parents feed the young? Do they swallow the food first and partially digest it, or do they give it directly to the young? How long before the young leave the nest? Are they the same color as the father and mother bird? A comparison should be made between the poor, little nest of the canaries made out of things we furnish, and the wonderful nest of the goldfinch, which is never made until the down of the thistle is available, and then from this delicate material a round, compact, beautiful, soft nest is built.

References: Audubon Educational Leaflet No. 17. Field Book of Wild Birds and their Music, p. 79. Second Book of Birds, p. 82. True Bird Stories, pp. 6, 9, 26, 45. Bird Life, 39, 148. Bird Neighbors, p. 190. Birds of Village and Field, p. 145.

THE OWL.

Preliminary Work.—An owl of any kind is not always at the behest of the nature-study teacher. As a rule, we do not advise the use of stuffed specimens for bird study; but it is with this as with the use of books, or the use of an object lesson for perfunctory information; it is valueless as a nature-study lesson. But if used to illustrate the peculiar adaptations of this velvet-winged night prowler, then either the stuffed specimen or the picture may be of real use. In country districts at least, this lesson should not be given until the pupils have heard the owls at night or until one has been captured, so that the observations may be made from the live bird. The teacher had best wait until circumstances arouse the interest and the lessons will follow as a natural result.

LESSON XCIX.

THE APPEARANCE OF AN OWL.

Purpose.—To call attention to the owl's adaptations for its peculiar life.

Its beak is strong and hooked for tearing flesh. The feet have four strong toes with long, sharp claws or talons; these are for seizing the prey. Note that the owl in grasping the perch may have two toes forward and two backward. The owls fly at night and their eyes are adapted like those of a cat for seeing in the dark. See "Bird Book," Eckstorm, p. 110. Note especially that the eyes look forward and do not turn in their sockets; the owl is obliged to turn its head in order to follow an object with its eyes. The owl's ear is very different from the ordinary ear of birds; instead of being a mere hole opening into the internal ear, it consists of a fold of skin forming a channel, which extends from above the eye around to the side of the throat. The owls through hunting at night are obliged to depend very largely upon sound to direct them in searching for their prey, and thus these remarkable external ears have been developed. Note how soft and fluffy is the owl's plumage and that the feathers used in flight are velvety and soft. Thus it is that the flight of the owl is absolutely noiseless. This is another adaptation for surprising the prey at night. In color owls are brownish or grayish and more or less spotted so that they are not noticeable either by day or by night.

LESSON C.

THE OWL'S HABITS.

Purpose.—For making the pupils familiar with the habits of the common screech owl.

This interesting little creature is known to almost all children outside of the largest cities by the long, mournful, whimpering cry, which it makes at night. The screech owl makes a most interesting pet if taken when young; it is a fascinating creature to watch and has a way of snapping its beak, which is apparently its method of expressing its own self-importance. The nest is made in a hollow tree, often in the deserted nest of a woodpecker. The eggs are white, and sometimes the two wise-looking little parents sit together on the eggs, a most happy way of passing the tiresome period of incubation; they are very constant in their affection and remain mated for life. The color of the screech owl's plumage varies greatly sometimes being gray and sometimes reddish-brown. This owl winters in this climate. Although it sees so well by night it can also see well by day. Its food is varied; it consists of

insects, salamanders, fish, frogs, crawfish, small birds and especially of mice, which it destroys in great numbers. In the warm weather in winter it stores in its winter quarters mice, moles, or other creatures, which it may be able to get, so as to have something to eat during the severe weather. It can be counted as a special friend of the farmer because of its destruction of mice.

LESSON CI.

HOW THE OWLS BENEFIT THE FARMER.

Purpose.—To inform the pupils concerning the owls common in our State and their economic value.

We have the Screech Owl common everywhere. The Barred or Hoot Owl and the Great Horned Owl frequent our larger forests and are found common in the Adirondacks. The Great Snowy Owl and the Saw-whet or Acadian Owl make us winter visits, occasionally coming down from the north. The Short-eared Owl is rare and the Long-eared is uncommon; the Barn Owl is occasionally found in the southern part of the State.

The owls have queer feeding habits; they swallow their prey as nearly whole as possible and in the stomach the digestible portions are utilized, and the hair, bones and other indigestible material are gathered into pellets, which are thrown out of the mouth. The bones in these pellets have revealed to the biologist just the kind of food the owls subsist upon. The Hoot Owl frequently attacks the larger birds and poultry, but it also feeds upon mice, rats, squirrels, frogs and fish. The Great Horned Owl is especially a depredator among poultry. This is the owl that gives a bad reputation to the others among farmers. The Short-eared Owl does not live in the woods, and it also hunts by day; it haunts marshes or grassy meadows where it hunts for mice and it makes its nest of hay and sticks on the ground instead of in trees. The Long-eared Owl or sometimes called the Cat Owl has an interesting way when disturbed of lifting up the tufts of feathers on the head; these look like ears, although they are not. These owls live mostly upon field mice, although they occasionally take small birds. They build their nests in trees, using deserted crow nests for the purpose. In the western states there is a most interesting species living in the burrows of the prairie dogs and rattlesnakes. They do not live with the prairie dogs, but take possession of their deserted holes. They have a funny way of bowing when they come up to the surface of the ground, which makes them seem very polite.

References.—"Birds That Hunt and Are Hunted," pp. 335-352. "Guide to the Birds of New England," Hoffman. "Birds of Eastern

North America," Chapman. "Birds of Village and Field," p. 287. "Story of the Birds," "The Bird Book," p. 110.

Supplementary Reading.—Audubon Educational Leaflets, Nos. 11, 12, 14. "Second Book of Birds," Chapters 32 and 33. "Winter Birds," Burroughs. The Boy and Hushwing in "Kindred of the Wild." Second Crops in "Wild Life Near Home." "Familiar Life in Field and Forest," p. 99. Wilderness Ways, p. 59. Wings and Fins, Chapter XIX. Heart of Oak Books, Vol. IV, p. 51. Prairie Dog Village, Irving.

THE MOUSE.

Preliminary Work.—A common house mouse may be trapped and kept in a cage in the schoolroom for a day or two for the purpose of observation. The cage should be placed where the children will see it, and five or ten minutes spent in watching the cunning ways of this little creature may be used as a reward of merit for good behavior or accomplishment of school work. The teacher may incidentally tell some of the following facts to increase the interest in mice: Our house mice came from ancestors which lived in Asia originally. However, these mice are great travelers and have followed men wherever they have gone all over the world. They came to America on ships with the first explorers and the pilgrim fathers. They now travel back and forth across the oceans in ships of all sorts; they also travel across the continents on trains. Wherever our food is carried they go. The mice which you see in your house one day may be one thousand miles away within a week; they come and go by their own hidden paths and for their own mysterious reasons. Mice are very clever and learn quickly to connect cause and effect. For two years when the editor was employed in the Department of Agriculture at Washington a bell rang at noon, which was a signal for all the clerks to open their lunch baskets and partake of the light midday meal. They threw the remains in the waste paper baskets, and the mice in the building soon learned to connect the sound of the bell with a possible meal. We would see nothing of them all the forenoon but within five minutes after the bell rang they would be present everywhere exploring the waste baskets for crumbs.

LESSON CII.

HOW TO OBSERVE THE MOUSE.

Purpose.—To teach how the mouse looks.

First of all note the color, for this has served the species well, and is one of the means of spreading it all over the world. Mouse-gray is perhaps the most inconspicuous color that there is: when a mouse is running along the floor the eye hardly takes it in, for it looks like a flitting shadow and thus escapes observation; if the mouse were black or white or any other color, it would be more often seen and destroyed. Note the erect ears, the bright black eyes; the legs while not long are adapted for swift motion; the feet are delicate but are used skillfully as

hands as well as feet; the tail is long and covered with a few scattered hairs; the teeth are like those of other rodents, two long, curved, gnawing teeth in the front of each jaw, then a bare space and four grinding teeth on each side of each jaw. Attention should be called especially to the gnawing teeth, for it is with these that the mice cut their passages through wood partitions or through other substances.

LESSON CIII.

HOW THE MOUSE ACTS.

Purpose.—To call the pupil's attention to the habits of the mouse.

Note how the mouse lifts itself on its hind feet to examine an object; it is constantly sniffing not only for danger but for things good to eat. Note the use of whiskers; and how the front teeth are used like hands for holding its food. Note especially how it washes itself using its front paws for scrubbing the head. If paper be put on the bottom of the cage the mouse will strip it off to make a nest. The young mice are small, downy, pink and blind when born. The mother makes for them a nice, soft, round nest of bits of cloth, paper, grass or whatever is at hand, and in the center of the ball she keeps her family. Mice living in houses have regular runways between plastering and the outside or between ceiling and floor; through these runways they pass all over the house. In winter they live on what of our food they can find, but they also do us a good turn by destroying all the flies or other insects that may have sought refuge in the cracks and crannies of our houses during the winter. In the barn the mice make their nests in almost any nook or cranny or sometimes in the middle of the hay or straw. Mice are thirsty little fellows and they like to make their nests within easy reach of water. The house mice sometimes live under the stacks of corn or grain in the fields, but usually confine themselves to buildings inhabited by man or domestic animals.

LESSON CIV.

DIFFERENT SPECIES OF MICE.

Purpose.—To make the pupils observant of the different species of our native mice.

We have quite common in New York State two species of wild mice, the Field or Meadow Mouse and the White-footed or Deer Mouse.

The Meadow Mouse.—The time to begin the study of this species is in the spring after the snow is gone, thus revealing their runways which go in every direction through the meadow. A trap may be set and one of these mice caught for observation. The field mouse is heavy bodied with short legs, short ears and

short tail; it is brownish or blackish in color. It sometimes digs burrows straight into the ground for a nest, but more often makes its nest beneath sticks and stones, and especially beneath stacks of corn and grain. It is the nest of the field mouse which the bumble-bee so often takes possession of after it is deserted. Field mice make their passages through the grass all summer in quest of food; in winter they constantly extend their runways underneath the snow, hunting for seeds and also feeding upon the bark of trees and shrubs. This mouse is a good fighter, sitting up like a woodchuck and facing its enemy bravely. It needs to be courageous for it is preyed upon by almost everything that feeds upon small animals; the hawks and owls especially are its enemies. It is well for the farmer that these mice have so many enemies for they multiply rapidly, and would otherwise soon over-run and destroy the grain fields. The field mouse is an excellent swimmer.

White-footed or Deer Mouse.

The White-footed or Deer Mouse.—This beautiful little creature may be trapped and studied, but it should be treated with great consideration or it may die of fright. It is found almost exclusively in the woods, although it sometimes comes out in the field for the grain harvest and finds refuge in places where corn is stored; it does almost no harm or damage of any kind. The deer mouse is very different in appearance from the meadow mouse. Its ears are very large, its eyes large and full and its tail very long. It is fawn-color or brown above, but its feet and undersides of the body are pure white. It makes its nest in hollow trees and limbs, sometimes quite high from the ground; in this nest it stores nuts for winter. We once found two quarts of shelled beech nuts in such a nest. The deer mice also like the red hips of the wild rose and many kinds of berries, in fact their food is almost identical with that of the squirrel. The deer mouse sometimes makes its summer nest in a bird's nest which it roofs over to suit itself. It is exquisitely neat in its habits, and has none of the disagreeable odor of the house mouse. The young mice are carried hanging to the mother's breast. We once tried to rear some young deer mice by feeding them warm milk with a pipette; although they were still blind they invariably washed their faces after each meal. For an interesting study of the deer mice see Tookhees the 'Fraid One in "Secrets of the Woods."

Jumping Mice.—These are not true mice but are closely allied to the kangaroo rat of the deserts; (see Lives of the Hunted). There are two species of jumping mice met with occasionally in our State; one of these is the meadow species, and the other is a larger species found in the woods, this latter being from eight to ten inches in length. Both species are yellowish in color and can be easily distinguished from the rue mice, because their hind legs are so much developed, and the hind feet almost twice as long as the front feet. When frightened they make very long and high jumps. The two species may be distinguished not only by the larger size of the wood mouse but also by its white-tipped tail. Both the species are white underneath and have white legs. They also are provided with cheek pouches in which they carry their food, as do the chipmunks. The meadow species is much more common than is the wood species, and it is more often seen after the meadows

have been mown in the summer. It builds its nest in burrows underground and, unlike the true mice, it passes the winter in a dormant condition in its nest.

References: Claws and Hoofs. Ch. XI. American Animals, pp. 102, 112, 131, 138; Secrets of the Woods, p. 1. Wild Life, Ch. X.

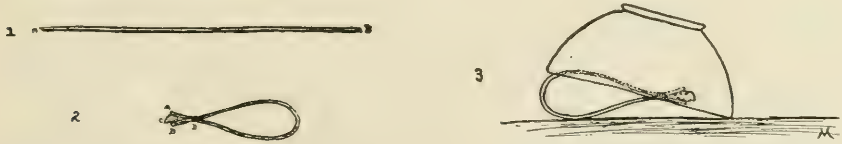
LESSON CV.

MICE TRACKS.

Purpose.— To familiarize the pupils with the habits of the wild mice in winter.

This must be field work accomplished by the pupils independently, and the results given in written or oral reports to the teacher. After a light snow has fallen, an early trip across meadows, along road sides and in fence corners will reveal to the observers many of these mouse trails. Note that the mouse usually bounds along, like a squirrel, and this makes a track in which the large, long prints of the hind feet are ahead of and outside of the smaller prints of the front feet. The tail dragging behind leaves a faint, broken line between the foot prints, almost continuous when the mouse proceeds leisurely, but with a distinct mark at each bound when the mouse is going rapidly. Have the pupils measure carefully and put in their note books (a) the width of the track; (b) the distance between the prints of the two hind feet. Ask them to follow the trail and try to interpret from it the story of the wanderings of the mouse, whether it found anything to eat or not, and whether it was followed by some enemy. If the snow is more than three inches deep, the trail will be a furrow, and may often be a burrow beneath the snow.

Track of the meadow or field mouse.



The Bow Trap. 1. A Smooth splint or a peeled twig. 2. Splint bowed and tied at D, the bait inserted at C. 3. The inverted bowl balanced on splint bow.

LESSON CVI.

TRAPPING FIELD MICE.

Purpose.—To teach the pupils how to trap humanely, and through the use of traps to identify the different species of field mice.

Probably wild animals suffer more cruelty through the agency of traps than through any other form of human persecution. The savage steel traps often catch the animal by the leg, holding it until it gnaws off the imprisoned foot and thus escapes maimed and handicapped for its future struggle for food; or if the trap gets a stronger hold the poor creature may suffer tortures during the long period before the owner of the trap appears to mercifully put an end to its sufferings by killing it. If box traps be used they are often neglected and the poor creature imprisoned is left to languish and starve. The teacher cannot enforce too strongly upon the child the ethics of trapping; impress upon him that the box traps are far less cruel, but that if set they must be examined regularly and not neglected.

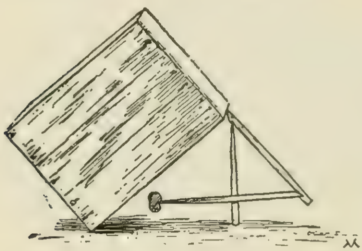


Figure 4 trap.

In studying mice give the children a good lesson in humane trapping. Let them set a figure 4 or a bowl trap and then bring their little prisoners to school so that they may be studied, meanwhile treating them kindly and feeding them bountifully. After a mouse has been studied it should be set free, even though it is one of the quite superfluous field mice. The moral effect of killing an animal after the child has become thoroughly interested in it and its life is always bad.

THE WOLF.

Preliminary Work.—We think it a good plan to preface the study of the dog with a study of the wolf, for after knowing the habits of wolves the pupils will be much better able to understand what the dog's life as a wild animal may have been. In New York State the study of the wolf must, of course, be a matter of reading, unless the pupils have a chance to study the animal in a traveling menagerie or in the New York Zoological Garden. It would be well to begin the work with a talk about the wolves that formerly inhabited America, of which we had two species, the Gray or Timber Wolf and the Coyote or Prairie Wolf. The Gray Wolf ranged in packs over New York State a hundred years ago; now it menaces the cattle herds on our western plains and holds its own in many of our forest preserves. The Coyote has learned to adapt itself to civilization and flourishes in the regions of the upper Missouri in Colorado to the Pacific Coast. If your school is situated in the western districts of New York, outside of cities, you may be able to find some person, who will remember the stories about wolves in that locality told to him by his parents or grandparents. Such a story would be the most desirable nucleus for beginning this study.

Use, Bulletin 72, by Vernon Bailey, United States Department of Agriculture Forest Service, to give the pupils a geography lesson on distribution of wolves now in the United States.

LESSON CVII.

WOLF STORIES.

Purpose.—To familiarize the pupils with the habits of wolves through reading and through exercises in written English.

Let the pupils read the following stories and get from them information about the habits of wolves on the following points, which may be made into an essay: What do the wolves feed upon? How do they get their prey? Do they follow their prey by scent and in packs, or do they hunt alone, like the panthers? How do they call each other? During the breeding season, do they still run in packs? Describe the den and where and how the young are reared. Compare the habits and form of the wolf to those of the dog.

Literature is rich with wolf stories. Although Kipling's famous "Mogli Stories" are based upon fiction, yet they contain very excellent accounts of the habits of wolves, especially as to the manner of taking their prey and their den habits. We have many thrillingly, interesting stories in our own literature, which teach more especially of our native wolves. The following are among the best: Lobo in "Wild Animals I Have Known;" Tito in "Lives of the Hunted;" Bad Lands Billy and the Winnipeg Wolf in "Animal Heroes," all by Thompson Seton; The Passing of the Black Whelps in "Watchers of the Trail," by Roberts; "Northern Trails," by Long; Pico Coyote by Coolidge in "True Tales of Birds and Beasts." For careful accounts of the wolves read "American Animals," pp. 277 to 283; The Hound of the Plains in "Wild Neighbors," by Ingersoll; The Life of Animals, p. 188. Poems: The Coyote, by Bret Hart; The Law of the Pack, "Second Jungle Book."

THE DOG.

Preliminary Work.—Any well disposed dog will do for a lesson on the way this animal looks and how it is adapted for its life. After the previous lesson the pupils will understand the necessities of the life of the dog as a wild animal, and it should be studied from this standpoint first. A collie or a hound would perhaps be the best for an object lesson.

LESSON CVIII.

OBSERVATIONS ON THE APPEARANCE OF THE DOG.

Purpose.—To call attention to the dog's adaptation for getting its living as a wild animal.

Note that the legs are strong; that the toes are well padded and the claws are st ong, but cannot be easily pulled back, like a cat's claws.

Experiment and see whether the dog walks on as many toes on the front feet as he does on the hind feet. Note that the whole strong leg and the tough feet are shaped especially for running down prey. Note that the dog has tushes for seizing and tearing its prey, and has grinding teeth for chewing. Let them see that when a dog gnaws bones, it does it with its back teeth. Note that the eyes are quite different from those of the cat; the dog's eyes are not fitted to see in the dark. Note that the hearing is very acute and that the outer ear is movable, so that it may be opened

Mateo, a St. Bernard of high pedigree.

in the direction of a sound. A good exercise for the pupils to teach them how much this helps in hearing is to bend a paper in the shape of a fan and place it behind their own ears and listen to some far away sound; they will be able to hear it much plainer with this help. Special stress should be placed upon the dog's sense of smell, which to us seems like a miracle. A fox-hound will follow a fox track all night guided simply by the scent, although the fox may have passed over the trail some hours before. Let them note that the dog recognizes friends or enemies by the scent. Note the covering of the dog; that it is hair instead of fur, like the cat's covering.

LESSON CIX.

THE DOG'S CHARACTER AND HABITS.

Purpose.—A study of the dog's character and how he expresses his emotions.

Get the pupils to write or tell stories of the devotion of the dog to his master and other stories which illustrate dog character. The dog expresses friendliness by jumping about playfully, barking joyfully, trying to lick the face and hands and wagging his tail in a friendly manner. It expresses fear or shame by dropping the tail between the legs and skulking off, giving a sidewise look. It expresses fright by yelping. It expresses anger by showing the teeth and growling. It expresses excitement in chasing its prey by barking. At night if the dog hears certain sounds it will howl; it often howls at the sound of music; this is a habit inherited from the wolfish ancestors, which called to each other by howling.

LESSON CX.

DIFFERENT KINDS OF DOGS.

Purpose.—To call the attention of the pupils to the difference in breeds of dogs.

This should be an observation lesson on all of the well marked breeds of dogs in the neighborhood. Of course, if the pupils have access to a dog show, this would give the best opportunity for this lesson. These studies may be made in the form of essays or given as an oral lesson. For help in studying the breeds of dogs the following references will be of assistance: "Country Reader," p. 116. "Chapters on Animals," pp. 1 to 37. "Familiar Animals," pp. 1 to 30. "Neighbors with Claws and Hoofs," p. 34.

The following are some of the common breeds which should be studied: Grey hound, fox hound, fox terrier, rat terrier, spaniels, bird dogs, collies, bulldogs, bull terriers, and pugs. Use stories for the basis in leading the pupils to understand the reasons for development of the three great dogs, the St. Bernard, the Newfoundland and the Great Danes.

References.—Chink in "The Lives of the Hunted." Stories of Brave Dogs from St. Nicholas. "Rab and His Friends." The Dogs of War, Outlook, January, 1907. Snap in "Animal Heroes." True Tales of Birds and Beasts, p. 123. Bob, Son of Battle. Special Methods in Science, p. 85.

THE FOX.

Preliminary Work.—If this lesson be given in rural districts, there will be plenty of stories which the teacher may elicit concerning the cunning and the cleverness of the red fox. In such places there will always be opportunity in winter for studying fox tracks upon the snow. The interest of the pupils in this night marauder is always great, and the lesson should begin with some recent appearance of a fox in the neighborhood. Special attention should be given to enforcing upon the pupils the close relationship between foxes and dogs. They make similar tracks, each barks, each runs down its prey, and often where the dogs are small enough, foxes have been known to play with them.

LESSON CXI.

WHAT THE FOX DOES.

Purpose.—To make the pupils familiar with the habits of the fox.

Unless there are hunters in the class this will naturally be a lesson from books or from stories of local hunters. Let the pupils answer the following questions through reading or through inquiring of fox hunters: Where do the foxes live? At what time of year are the young born? Do both parents care for and provide for the young? What is the chief food of the fox in the summer? In the winter? Bring out the fact here that the fox is an aid to the farmer in ridding him of several pests, like mice, grasshoppers, etc. When chased, does the fox run away? Does it run in circles? What are its tricks for throwing the dogs off scent? How does the fox carry its prey?

References.—Probably the best fox story is "Red Fox" by Roberts. This is a complete volume and although it belongs to animal fiction, yet it is based upon fact and is a most interesting book, presenting a wholesome picture of the life of a successful fox. Other references are: "American Animals," p. 264. "Little Beasts of Field and Wood," p. 25. "Squirrels and Other Fur Bearers," Chapter VII. Fox Ways in "Ways of Wood Folk." The Springfield Fox in "Wild Animals I Have Known." "Familiar Life in Field and Forest," p. 213. "Nights with Uncle Remus," which through fable and folk stories illustrate the cunning of the fox.

THE CECROPIA.

Preliminary Work.—During the fall and winter ask the pupils to bring in the cocoons. The cecropia cocoon is the one called the cradle by the children; it is made of thick silk hung along the lower side of a twig. After the cocoons are brought into the schoolroom they should be kept in a box covered with wire netting and placed outside of the window sill where they may have natural conditions. If kept in the schoolroom they should be dipped and thoroughly soaked in water at

least once a week. The advantage of keeping them outside is that they will not issue until the leaves appear upon the trees, so that there will be food for the young caterpillars to eat as soon as the eggs hatch; while those kept in the house usually come out earlier and there is no chance for rearing the caterpillars.

LESSON CXII.

THE MOTH.

Purpose.—To call the pupil's attention to the way the moth gets out of the cocoon and to familiarize them with the color and markings of the insect.

One cocoon should have been opened so that the pupils may see the pupa of the moth, so that they will know that before the moth can issue

from the cocoon it is obliged to shed the pupa skin. After this is done it throws from its mouth a quantity of fluid which dissolves the gum which holds the silk of the cocoon together. This enables the moth to push the valve end of the cocoon open. Note that on each side of the head are two little, horny hooks, which may be felt rather than seen; these assist the insect in pulling itself out. The scratching sound heard in the cocoon before the moth emerges is largely made by these hooks rubbing against the stiff silken lining. Note that as the insect issues the body and wings are all soft and wet; otherwise it could not come through so small an opening. Soon after issuing the crumpled wings spread out and dry and the matted covering of the body becomes fluffy and feathery. Have the pupils describe, or better still, draw the

Cocoon of cecropia.

moth, giving details of color and markings of the wings, and the form of the antennae. Note that the mother moth is larger than the father moth, but the latter has much larger antennae. These great feathery antennae contain organs for smelling. Note that the moths do not need to eat during the few days of their winged existence and, therefore, have poorly developed mouth parts. The pupils should understand that the caterpillar which devoted all of its time to eating, stored up enough energy so that the moths do not need to eat. Note that the moths are quiet by day and active by night, and that they are attracted by the light.

LESSON CXIII.

THE PUPA.

Purpose.—To make the pupils familiar with the pupal form of the cecropia.

Cut open a cocoon carefully so as not to hurt the little inmate; take the insect out, place it on cotton in a wide-mouthed, quart fruit jar where it may be observed, and also where the change from pupa to adult may be watched. Call attention to the fact that the pupa is defenseless and can move only a very little when disturbed. Make the pupils reason out for themselves that the cocoon is such a perfect protection that the pupa does not need to defend itself. Note that though the pupa is covered by a smooth, hard skin the parts of the moth are plainly to be seen. The antennae and both pairs of wings are folded over the breast. Count the rings in the abdomen; it is plain that this is another instance where nature does up a great amount of material in a very small package.

LESSON CXIV.

THE COCOON.

Purpose.—To call the attention of the pupils tc the wonderful construction of this silken nest.

Note that it has a coarse covering outside and a smooth silken lining and that between the two there is a loose filling of silk. Explain that this is a device for protecting the insects both from the changes of temperature and from dampness; and it also makes it more difficult for a bird to tear the cocoon apart. Note that at the end of the cocoon where the moth issues, the silk is not woven across but is put on lengthwise so that the end of the cocoon will open like a valve. Explain that this was done by the caterpillar so that the moth could get out more easily. At the same time it is well to explain that this is instinct and not forethought. See Vol. of Cornell Nature-Study, p. 168.

LESSON CXV.

THE EGGS.

Purpose.—To call attention to the appearance of the eggs and to the provision which the mother moth makes for her young.

The mother cecropia if allowed her freedom is very careful to lay her eggs upon a plant or tree the leaves of which afford acceptable food for her young. These trees are usually apple, plum or wild cherry. The eggs are cream white, about as large as the head of an ordinary pin, and they are laid in small clusters in short rows, sometimes on the upper surface and sometimes on the lower surface of a leaf. If some of the eggs are kept out-of-doors and some are brought in the house the pupils will notice that those in the warm temperature hatch sooner. Explain the benefit of this habit to the caterpillar, for if the weather is very cold in the early spring, the leaves do not grow rapidly and, therefore, it is better for a caterpillar not to hatch so soon. If the moth reared in the schoolroom lays the eggs, they are likely to "cave in" and not hatch, because they are not fertilized.

LESSON CXVI.

THE CATERPILLAR.

Purpose.—To interest the pupil in the life-history of the moth of the cecropia.

The chances are against being able to study the caterpillar during the school year. If you watch the hatching of the eggs in the spring the young caterpillars may attain part of their growth before the middle of June. Occasionally a belated caterpillar in the last stages may be found in September and if so this should be a mine of wealth in the nature-study class, for it may be observed building its cocoon. If the children are familiar with the moth the cocoon and the eggs, it may be well to tell them the story of the caterpillar something as follows: From the egg hatches a tiny caterpillar about one-fourth of an inch long, very dark and with six spiny warts on each segment. It eats and eats for four days, using the leaf on which it was born for food; then its skeleton skin becomes too tight and finally bursts and is pushed off, and new skin is formed under the old one, which is elastic at first and gives the little fellow plenty of room. This skeleton skin looks

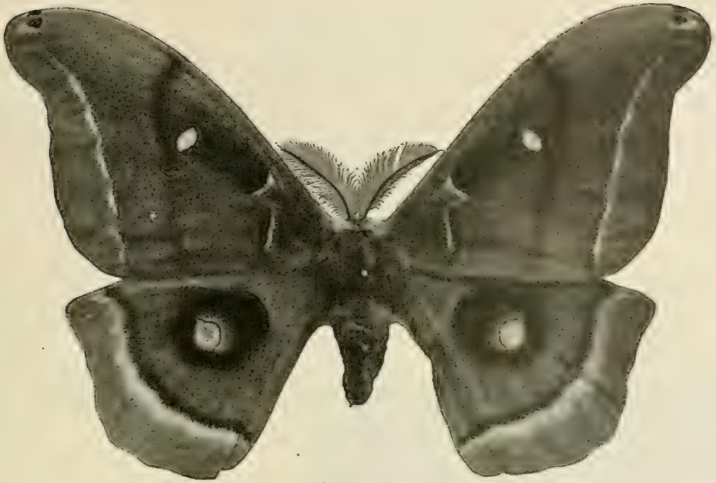
different from the first one; it is dull yellow or orange and the spiny warts are black. After it experiences the comfort of the new skin it falls to again and eats as fast as it can for about a week, only now and then taking a little time for rest. Again it finds its skin too tight and is obliged to shed it. This time the new skin is bright yellow and the warts begin to show off as real ornaments; those on top of the first segment next to the head are blue, the next two segments are orange-red and all the others are blue with black spines, except on the very end segment, which has one large, yellow wart ringed with black. In this new, commodious and handsome skin it lives for another week eating more voraciously than before; then the skin is changed again and this time the whole body is a delicate bluish-green and the big warts on the front are orange, all the others are yellow except those on the first and last segments, which are blue. This is its final color and form, for although it changes its skin once more it does not noticeably change its color. When it reaches its full growth it is a very large caterpillar, as large as a man's thumb. It continues to eat for two weeks or so after it sheds its skin for the last time and then it begins to think about spinning a cocoon. It often wanders about on a tree before it finds a place which it considers suitable. It starts the cocoon by making a framework of silken threads, which it spins from a gland in its lower lip. This framework consists of a few strands of silk, stretching from a twig to a bit of leaf then looped back to the twig. It weaves the body of the cocoon by laying on the silk in the shape of continuous M's or figure 8's. After a short time the caterpillar is completely hidden from our sight by this curtain of silk. How it finally finishes the cocoon on the inside no one knows, but it must be a very skillful performance, for the lining is so close that it squeezes the caterpillar. It is like a man building a box just to fit him, always working from the inside instead of the outside; or like a woman sewing herself up in a bag. When finally the cocoon is made, the ornamental skin is pushed off at the end of the body, and the pupa quite smooth and brown takes possession of its winter home.

LESSON CXVII.

THE POLYPHEMUS.

Preliminary Work.—The work on the polyphemus may follow in outline that given for the cecropia. It might be well to interest the pupils particularly in the polyphemus as a silk worm, because the silk of the polyphemus cocoon is the strongest and smoothest and most lustrous and durable of any of the American silk-worm cocoons. Very handsome and durable silk cloth is made from these cocoons; a single one furnishing eight hundred feet of good silken thread when it is softened and unwound. The only reason these moths have not been used for producing silk cloth is that they are not domesticated, and are not as easily taken care of as are the caterpillars of the Chinese silk-worm, a species which has been domesticated for many centuries.

In comparing the polyphemus with the cecropia the following differences should be noted: The cocoon is not long and cradle-shaped, but is a very blunt oval in shape. It is not double walled with a filling of loose silk. It is never woven close upon a twig, but sometimes chances to encompass in its strands a twig or leaves. Usually it is made among several leaves which are fastened to the outside and it falls to the ground in the autumn and remains safe under the snow during the winter. However, if it chances to be fastened to a twig it remains upon the tree until spring. The common food plants of the larvæ are elm, maple, chestnut, walnut, beech, birch, apple, wild cherry and some others. The eggs are flat and



Polyphemus moth.

round, the top and bottom whitish, with a brown band around the sides. They are laid in clusters, usually on the underside of the leaf. The caterpillar when first hatched has a large, reddish head and yellowish body; in its later stages it is green along the sides and bluish above. When fully grown its body is an exquisite green with oblique yellow stripes along the body segments; the ornamental warts are orange or sometimes coral-red. The head is reddish-brown and the shield on the last segment is bordered with brown. The moth affords an excellent subject for a drawing lesson in water colors. The one thing to fix in the pupils' minds so that they will distinguish this from the other giant silk-worm moths is the "window pane," one small, oval, transparent spot in each wing. In the hind wing this is the center of a very striking eye-spot. Have the children read the story of Polyphemus in connection with this moth. See Heart of Oak, Vol. IV, p. 113.

References for Cecropia and Polyphemus. — Cornell Nature-Study Leaflet, Vol. II, No. 3. Cor-168, 546. "Moths and Butterflies," Dickernell Leaflets, pp. 167, son from page 156 to 180. "Caterpillars and Their Moths," Chapter 12. "Moths and Butterflies," Ballard, p. 70. Manual for Study of Insects, 352, 357.

Polyphemus cocoon.

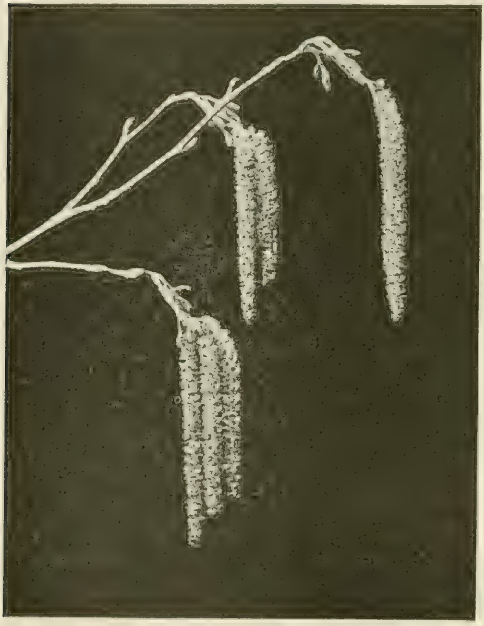
THE ALDERS.

Preliminary work.—When gathering twigs in the early spring for forcing in the sunny windows, cut some longer twigs of the alders. These alder twigs may have upon them the staminate and pistillate catkins, the leaf buds and the last years' cone-like seed vessels.

LESSON CXVIII.

HOW THE ALDER LOOKS IN WINTER.

Purpose.—To teach the pupils to observe the trees in winter and to notice that during this apparently lifeless period they are providing for future activity.



Alder blossoms.

Note carefully the appearance of the twigs before bringing them in-doors; note that there are buds of different sizes and shapes on different parts of the branch. If the teacher is provided with a hand lens, and she should surely be thus equipped because of the added interest this gives to most nature-study work, let her uncover a bud by removing the scales with a sharp-pointed pen knife and carefully open what lies within, and she will find a cluster of leaves plaited and folded closely; they are velvety and green and full of life, even in mid-winter. During the past summer after the leaves had been fully developed and had made the year's growth of wood, the tree began to get ready for next year. Tiny green catkins began to form at the ends of the twigs, and by the end of September were about an inch long, round, hard, green and glossy; the winter frost may brown them a little, but does them no harm. These are the staminate catkins and are all in readiness so that the first touch of spring warmth and sunshine causes them to "tassel out," which means the thrusting forth of the anthers filled with pollen. The pistillate buds are small and cone-shaped, and situated just below the staminate catkins and on the same twig.

LESSON CXIX.

THE USE MADE OF THE ALDERS.

Purpose.—To inform the pupils concerning the chief uses of alders.

The alders are even greater lovers of water than are the willows; when planted on the banks of swift streams their strong, interlacing roots prevent the water from "washing," and thus save many acres of land. Alder wood when exposed to changes of wet and dry soon decays; but strangely enough if kept saturated in water is durable, so it is used for water pipes and for piles; the ancient cities of Venice and Amsterdam were built on a foundation of alder piles, according to an old authority. Ink and a fast black dye are made of alder bark, and tannin is obtained from both the bark and the fruit.

The Speckled or Hoary Alder is the most common in New York State, and may be easily distinguished by its wide, speckled, brown branches and by its pointed leaves lined with a hoary bloom, which they lose later in the season. Our native alders are shrubs, rarely attaining more than ten feet in height. However, we have a European species which is a good sized tree.

References.—"The Tree Book," p. 177. "Our Northern Shrubs," p. 460. "Our Native Trees," p. 460.

LESSON CXX.

THE WANDERER.

Purpose.—To make the pupils interested in this very interesting and beneficial butterfly, which feeds upon the alder blight.

THE WANDERER.

Expanse a little over an inch. Color dark brown with large irregular orange-yellow patch in the central part of the fore wing and a similar patch on the outer half of the hind wing.

There is a plant-louse which fastens itself to the twigs of alder, which is protected by a woolly covering; a twig thus infested may be easily seen, for it looks as if it were wrapped in cotton wool. These plant-lice excrete large quantities of honey-dew which is much liked by the ants. This honey-dew is excreted in such large quantities that it blackens whatever it falls upon and there grows upon it a fungus. Almost all caterpillars of butterflies feed upon vegetable food, either leaves or blossoms, but there is one notable exception, as the larva of one butterfly feeds upon these plant-lice on the alders; it works along beneath the woolly excretion destroying the insects in its

path. When disturbed it will drop by a silken thread for a long distance, and after the danger is passed will crawl back up this rope and begin feeding again. This caterpillar is destroyed by the ants whenever they discover it, as the ants are the special protectors of the plant-lice because of the honey-dew, and probably this habit of the caterpillar's of dropping by a silken rope out of the way of the fierce ant is a method of saving its life. The butterfly is a little copper-colored creature, which appears in May or June until the end of September. It is often found basking in the open places near elder bushes.

References—"Every Day Butterflies," p. 277. "How to Know the Butterflies," p. 237. "Insect Life," p. 163.

Willow shedding its seeds.

THE WILLOW.

Preliminary Work.—As early in March as is practicable have the pupils gather twigs of as many different kinds of willows as can be found. These twigs should be as large as can be conveniently cared for, for the larger the twig the more nourishment it can give to its blossoms and leaves. These twigs should be placed in buckets or jars of water and put in a warm, sunny window. After a little they will respond to this change of temperature by pushing off all the bud scales and developing their catkins. In most of the willows the pollen-bearing flowers are borne on one tree and the seed-bearing flowers are borne on another. The "pussies" with which the children are most familiar, are the pollen-bearing catkins, but there is little use in studying these unless the seed-bearing catkins are also studied. The bees carry the pollen for the willows, for without them the seeds would not develop. Therefore, this is an excellent opportunity to impress upon the child the necessity for insects as pollen carriers.

LESSON CXXI.

THE WILLOW BLOSSOMS.

Purpose.—To lead the children to observe the pollen-bearing catkins and the seed-producing catkins of the willow,

and to call their attention to the work of the bees as pollen carriers.

Observe that on all the twigs the buds are alternate and that none are strictly terminal. Compare the scales which cover the buds with those of other trees; notice that the bud is protected by a single scale, which soon falls off. Note that as the pussies develop those on one twig may be very different from those on another. Note that from the soft fur of one will come the silvery stamens tipped with golden or purple anthers. Note the anther is a two-celled pollen box filled with pollen, which falls with every breath or jar as they ripen. Note that the other kind of flowers are smaller, greenish-gray and not so soft and furry. These are the pistillate catkins each consisting of many blossoms, and every pistil having its own silky scale. After the pollen has fertilized these blossoms they will turn to tiny pods, two-valved and beak-like, which open like the milkweed seed, setting free the tiny seed balloons within them. When these fuzzy seeds are being set free people say that the willows "shed cotton."

After the pupils have studied in the schoolroom these different blossoms and come to understand that the pretty pussies are simply the pollen-bearing catkins, they should make observations in the field.

Pollen bearing catkins of the willow, "Pussies."

The pollen-bearing flowers of the willow are almost the earliest food which the bees find in the spring; they are at their prettiest in April, and at that time a pussy willow tree is filled with the hum of the bees working upon its blossoms. The bees visit these blossoms for the pollen, which they eat and make into bee-bread for feeding their young. There is no honey developed in these flowers, but the pistillate blossoms develop some nectar so that the bees covered with pollen will visit them, and thus bring to them the precious life-giving dust. In June the willow seed is ripe and the pupils should carry on their observations until they see these masses of fuzzy, seed balloons scattered everywhere by the wind.

LESSON CXXII.

HOW WILLOWS ARE PROPAGATED.

Purpose.—To teach the pupils that willows have other methods of propagation than by planting seeds.

Although the seed of the willow is produced in abundance, it seems as if it were hardly needed for preserving the species. Note that the twigs which have been kept in water to develop flowers will also put forth roots; even if the twigs are wrong end up the rootlets will form. A twig lying flat on moist soil will push out rootlets along its entire length as though it were a root and shoots will grow from the buds on its upper side. This habit of the willows makes it of great use to man as a soil binder. As a protection from streams that wash away their banks during floods, there is nothing better than a thick hedge of willows; the roots will reach out in all directions, interlacing themselves in great masses and thus hold the soil in place. If possible, have the pupils observe the roots of the willows on the banks of some stream. Many streams are bordered by self-planted willow hedges, for the wood is weak and the twigs are easily snapped off by the wind and float down stream, taking root wherever they are stranded. One species is called the Sand-bar Willow for this reason.

Seed bearing catkins of the willow.

LESSON CXXIII.

THE USES OF WILLOW.

Purpose.—To inform the pupils of the many uses to man of the willow wood.

Perhaps the most interesting use of the willow to the children is the manufacture of whistles, black willow being the best for this purpose. Though willow wood is soft and exceedingly light it is very tough when seasoned and is put to a surprising number of uses. The wooden shoes which the European peasants wear are made from willow for first choice and poplar as second choice. It is used instead of cork in making artificial legs and arms for the maimed. Ropes and baskets are made from willow twigs since the earliest historical times. The Britons fought the Roman soldiers from behind shields of basket work; the wattled huts in which they lived were woven of supple

willow saplings smeared over with clay. In Europe willow raising and willow weaving is now a regular industry; baskets, hampers, carriage bodies and furniture are made for all the world. To get these twigs the willow trees are "pollarded," which means they are cut back every year between the falling of the leaves and the flow of the sap in spring. In America large nurseries often grow willow to be cut back to the ground every season for the making of withes for binding the bundles of young trees. The making of willow ware in this country is a neglected industry, the only center of much importance being at Syracuse, N. Y. From willow is made charcoal of the finest grain, which ignites most readily and is, therefore, used in the manufacture of gun powder. Salicylic acid used widely in medicine is made from the willow bark, which produces also tannin and some unfading dyes.

Because the willow so readily hybridizes it is a very difficult group to study with a view of determining species.

References.—"The Tree Book," Rogers, page 115; "Our Native Trees," Keeler, page 393; "Getting Acquainted with the Trees," McFarland, page 97; "Familiar Trees and Their Leaves," Mathews, page 111; "With the Trees,"—Going,—36; "Practical Forestry," Gifford (Basketry, 16; Soil Binding, 58; Pollarding, 183).

LESSON CXXIV.

THE PINE CONE WILLOW-GALL.

Purpose.—To teach the pupils that the cone-like object found on several species of willow is not the fruit of the willow but is made by an insect.

There appears on the end of the twigs of the Heart-shaped Willow and certain other species, which grow about our streams, a cone-like object. This is naturally considered a fruit by the ignorant. As we have seen, the willow fruit consists of very small seeds, which sail away on tiny balloons and the trees which have cones for fruits are the evergreens. This willow cone is made by a small gnat, which lays its eggs at the tip of the twig; as soon as the little grub hatches it begins to gnaw the twig, and this irritation for some reason stops the growth. The leaves instead of developing along the stem are simply dwarfed and overlap each other. Just in the center of the cone and at the tip of the twig the little larva lives its whole life surrounded by food and protected from enemies; it remains safe in this cone all winter and in the spring changes to a pupa, and after a time comes forth a very delicate, little fly. The larva of this cone-gall is very hospitable; it has its own little apartment at the center, but it does not object to the spaces between

the lapping leaves being used by visitors, and another gall gnat takes advantage of this hospitality and breeds in large numbers in these outer chambers. It is well to gather these cones in the winter; examine one by cutting it open to find the owner and place others in a fruit jar with a cover on so as to see the little flies when they shall issue in the spring. (See illustration on first page.)

References.—" Outdoor Studies," Needham, p. 24. " Manual for the Study of Insects," p. 445.

LESSON CXXV.

A WINTER TENANT OF WILLOW LEAVES.

Purpose.—To get the pupils interested in looking for the larva of the Viceroy butterfly.

On some of the willows, especially the lower branches, may be found during winter and spring, leaves rolled lengthwise fastened into a cup. This little cup is very full of a caterpillar which just fits it, the caterpillar's head forming the cover to the opening. This is the partially-grown caterpillar of the Viceroy butterfly. It eats off the base of the leaf each side of the mid-rib for about half the length, then rolls the base of the leaf into a cup, lines it with silk and backs into it, there to remain until fresh leaves on the willow in spring afford it new food.

Winter nest of viceroy caterpillar.

References.—" Ways of the Six-Footed," Chapter III. " Manual for the Study of Insects," p. 409. " Moths and Butterflies," Dickerson. p. 101. " Everyday Butterflies," p. 297. " How to Know the Butterflies," p. 170.

TULIPS.

Preliminary Work.—The tulip should be a common flower in every country garden, for the bulbs are cheap and the cultivation very easy. It is especially fitted for the school grounds and school gardens, since it blossoms in the spring while school is still in session, and the children may have the pleaure of setting out the bulbs in the fall and getting the returns in the spring. There are a great many varieties of these flowers, very early kinds begin to bloom in April, while late ones may be in fullest blossom on Decoration Day; they vary in size and height from the " Little Lady " tulip with flowers hardly larger than a crocus to the tall Darwin and Parrot tulips with stems more than two feet long. The colors also vary from red, yellow, pink and white, to stripes and splashes of many hues. Water color drawings should play a large part in the study of the appearance of tulips.

LESSON CXXVI.

THE TULIP.

Purpose.—To familiarize the pupils with the various forms found in the tulip flowers.

The single tulips are best for beginning the study; they have usually what the children will naturally call six petals set in a double row. This is an excellent opportunity for teaching the pupils that the parts of a flower are not always what they seem, for, strictly speaking, the three outer ones are sepals and the three inner ones petals, but they are colored alike and the botanists do not separate them into petals and sepals, but take them together and call them the perianth, and the parts are call segments of perianth. Thus the perianth of the tulip has six segments, three outer and three inner ones; these segments are beautifully colored and are thin, smooth and silky in texture. Note that the segments of the perianth in some tulips are short and round and in some they are long and pointed; in some the perianth opens wide, like a shallow cup, in others it is deep with a constricted opening. Note there are six stamens about the single pistil and that the latter has a three-parted stigma set very directly upon the ovary or seed box. The tulip seeds very freely but it should not be permitted to do so, for it cannot mature both seeds and new bulbs. One or two plants may be saved for seed, so that the pupils may have an opportunity for studying the curious three-sided seed vessel with its numerous flat seeds.

LESSON CXXVII.

TULIP LEAVES AND BULBS.

Purpose.—To cause the pupils to study more closely and in detail the tulip plant.

Observe that the leaves are thick, smooth, veined lengthwise, and that the inner ones are folded within the outer ones. The leaves are quite broad and seem to have a crease or fold in the middle; some are straight edged, others are slightly curled or ruffled. Besides the large, broad leaves from the center of which the flower springs, there are smaller ones which grow on alternate sides of the thick stem. Note that the bulb is formed of several coats or layers, each one of which when it extends upwards grows into a leaf. This shows that the bulb is made up of leaves which are thickened by the food stored within them to be used for future growth. In the heart of each bulb is the flower bud, sheltered and protected by the stored food, which it will use later in its development. Note that the true roots are white and thread-like,

clustering like a thick tassel on the bottom of the bulb, and reaching deep in the soil for food.

LESSON CXXVIII.

THE CULTIVATION OF TULIPS.

Purpose.—To awaken in the pupils an interest in the growing of these beautiful flowers.

Tulips are very accommodating; they will grow in almost any soil if it is well drained, so that excessive moisture may not rot the bulbs. In preparing a bed it should be rounded up so as to shed water; it also should be worked deep and made rich. If the soil is stiff and clayey, set the bulbs only three inches deep with a handful of sand beneath each. If the soil is mellow loam, set the bulbs four inches deep and from four to six inches apart each way, depending on the size of the bulbs. They should be near enough so that when they blossom the bed should be covered and show no gaps. Take care that the pointed tip of the bulb is upward and that it does not fall to one side as it is covered. October is the usual time for planting, as the beds are often used for other flowers during the summer. However, September is not too early for the planting, as the more root growth made before the ground freezes the better; moreover, the early buyers have best choice of bulbs. The beds should be protected by a mulch of straw or leaves during the winter, which should be raked off as soon as the ground is thawed in the spring. The blossoms should be cut as soon as they wither, in order that the new bulbs which form within and at the sides of the parent bulb may have all of the plant food, which would otherwise go to form seed. Tulips may be grown from seed, but it takes from five to seven years to obtain blossoms, which may be quite unlike the parent and worthless. The bulblets grow to a size for blooming in two or three years; the large one which forms in the center of the plant will bloom the next season.

LESSON CXXIX.

THE HISTORY OF TULIPS.

Purpose.—To give the pupils an interest in the Netherlands and in the history of this characteristic flower.

Tulips came originally from Persia and were brought to Europe in the sixteenth century. About one hundred years later in the Netherlands was developed a remarkable interest in these flowers, which was termed the "tulip mania." Growers of the bulbs and brokers who bought and sold them joined in the great gambling speculation. Rare varieties of the bulbs became more costly than jewels, the sum of 4,600 guilders being paid, it is said, for one bulb of a famous black tulip.

Let the pupils work out the equivalent of this sum in United States money to see how extravagant were these seventeenth century Hollanders. The growing of tulips has been one of the regular industries of the Netherlands ever since. The soil has proved particularly well suited for this industry and the best bulbs on the market are those exported from Holland where they are grown by the acre. The tulip is still the favorite flower of the Netherlands, and rich and poor have it in their gardens.

THE MAKING OF SOILS.

JOHN W. SPENCER.

In the issue of October, I suggested that the teacher take her children down to the brook on some Friday afternoon for a field excursion. Among the things of interest to be seen I spoke of some mills where stone flour was in process of being made.

I did not then have the space to tell you all that I should about the process of stone flour being produced by other mills than those I mentioned. If the teacher has learned her physical geography to good purpose, she should be able to give her pupils a story full of interest concerning the Great Glacier that slipped down from the north, and a part of which spread over the State of New York.

In telling this story, take pains that the pupils do not confuse glaciers with avalanches, monks, mountain huts and St. Bernard dogs with small kegs strapped beneath their necks. The Alpine avalanches move with a rush and a roar. Glaciers may be found to-day in the Alps, Greenland and Alaska, and they move very slowly in comparison,—some of them but a few feet during a year, others 75 feet a day.

I do not know for how long a time the Great Northern Glacier covered the Eastern States but that such a condition existed, we have abundant proof. (For account of glacier and glacial period see "Introduction to Physical Geography," Gilbert & Brigham.)

LESSON CXXX.

EVIDENCE OF THE GREAT NORTHERN GLACIER.

Purpose.—To interest the pupils in observing that boulders scattered over many portions of New York State are not like the local rock; and also to teach them to look for glacial scratches.

Material.—The hard round stones of granite which the pupils will be able to collect in the neighborhood of the school. If there are any bare rocks in the vicinity look on them for glacial scratches which show in parallel lines.

The teacher can call the attention of her pupils to the granite boulders that are so frequently found over field and woodland of all that part of our country once covered by the Great Northern Glacier. She may call them visitors from the north. Why do we know that they have come from far away? For the simple reason that in all the stone quarries in New York no granite of that peculiar kind is found except

in the Adirondacks. The statement is made that away up north in the British possessions, stone of the identical kind as the boulders is found. That being the case, it is reasonable to suppose that those rocks were caught up in the mass of ice and brought down here. When weather conditions changed, and the glacier retreated or melted back, the stones were left on the spot where the glacier dropped them. As they came floating down with the slowly moving ice, great pushing of rocks against other rocks went on. In this rubbing and grinding of big stones into little stones, the same results followed as was the case of the stones in the stocking I spoke of in the October issue. To a geologist trained in such observation, scratches may be found where one boulder made grooves in another boulder.

I have had a stone for a number of years that shows glacial scratches. It is not a large one—about the proper size for throwing at a woodchuck—and it was broken from a larger piece. Besides the glacial scratches it bears other evidences of roughing it as a traveler for all the edges are rounded and smooth.

A scratched limestone pebble taken from a glacial soil.

What happened to my woodchuck stone happened to millions and millions of other stones big and little. By this, the teacher will understand that glacial action was of great importance as a mill for making stone flour.

Parenthetically, let me say that to me physical geography is one of the most interesting subjects taught in our schools and is an easier subject for interesting children than that of Greek myths. It has a probability of truth and is not a figment of the imagination. If I hear children complain of dullness of this topic I think they must have some peculiar cast of mind or the teacher has made a muddle of the subject.

LESSON CXXXI.

THE RELATION OF STONE FLOUR TO FERTILE SOIL.

Preliminary Work.—A lesson should be given on organic and inorganic matter—to distinguish between matter which was never alive and matter which was built up by living creatures. Let the pupil begin on the objects in the schoolroom and

enumerate those that are the result of life. The wood of desk and floor was made by living trees. The wool of the rug was made by sheep. The glass was made from minerals and was never alive, etc. Thus get the pupils to thinking what part life has played in their surroundings.

Purpose.—To teach the pupils to distinguish between organic and inorganic matter in the soil and also to teach them to identify stone flour.

Stone flour, while an important factor of the soil is not the only necessary ingredient. It is but the half of a pair of shears. Organic matter is the other half. Neither alone affords the ideal means for the production of plants. When the two are mixed under proper conditions and proportions, the result is a productive soil.

The teacher should be able to recognize stone flour. I know of no place where it is more easy to identify than when passing through a cut on the highway or seen from the car windows when traveling. Two colors will be seen. First the black or dark colored rind and below that comes the stone flour. The dark colored skin is the productive soil. In most instances, the excavation from a cellar after the first foot or two has been passed is stone flour and of itself is infertile.

Teach your children that soil is composed of stone flour and organic matter mixed. The term organic may seem to be too much an importation from chemistry to be teachable in the lower grades. I am not so sure of that. In one way and another, you can announce to your class that some forms of matter were once living and growing things. Then appeal to them to tell you if the wood part of their desk ever had life and growth. If of wood it was once a tree and a tree certainly once had life and grew. Now has the iron support of the desk ever had life? After elaborating the substances that have had life, and those that have not, ask your pupils to make a list of all the substances that they can call to mind and put them into one column or the other—organic or inorganic. If this exercise is given in the spirit of the old-time spelling down, it need never be dull. Children may be taught a lot of subjects commonly thought beyond their years provided the matter is translated to their understanding and given in small doses in the concrete.

The grooved bed-rock scratched by the movement of the ice sheet over it.

There are some substances that the chemist and the biologist do not agree as to the proper class to which they belong—like the oyster shell.

Such may be omitted for when doctors disagree, how are boys and girls to know?

LESSON CXXXII.

HOW SOILS ARE MADE.

Purpose.—To show how organic soil was first produced in Geological times and became mixed with the stone flour. Also to identify lichens growing on rocks, trees, fences and barns.

As I said before, soil is stone flour and organic matter mixed. Here comes a puzzling question. After the glacier had passed and nothing but stone flour lay over the face of the earth and that as infertile as the stuff from the bottom of a well, how was vegetable matter to begin to grow?

Let every member of your class take another field excursion for an inspection of rocks for the purpose of learning how organic life began.

A view over the hummocky surface of a part of the Moraine of the great American ice sheet in Central New York.

Examine the field rocks or a stone wall and study it closely. Search for little cavities where some flour may be found, perhaps less than a thimble full. By careful observation, growing threads or specks of lichen may be found growing from that small portion of stone flour. The amount may be that small as not to give shade to a lady bug, but that makes no difference, it will show the process of soil formation. That tiny bit of lichen—your pupils may call it moss which gains its nourishment from the air and rain—will not remain there forever. The time will come when like all other growing things it must die and find a grave in that thimble full of stone flour. No matter, the small cavity in the rock will hold

another crop of lichens and other growing (organic) things and those too will in time die and find their grave in the thimble full of soil.

This is the process in miniature whereby stone flour and organic matter began to make soil. Let the crop of lichens grow and die for a thousand years, the accumulation during that time will be quite perceptible and because of the increase of the grave, the stature of plants would increase also. A thousand years is a long time as compared with our lives, but in Nature it is as but yesterday. I think the Bible says something of the sort.

Here let me give you a definition of the soil that everybody may remember.

The soil is the Sepulcher and the Resurrection of all Life.

This is literally true—as true as the statement that coal is bottled sunshine—sunshine that encompassed the earth untold centuries ago. The sunshine became locked up in vegetation and by a process of Nature, the vegetation was changed to coal.

As I have told you, the tiny lichen found its sepulcher—its grave—in the thimble full of stone flour and from this sepulcher—came the resurrection of other lichens. As the process was repeated year after year and hundreds of years after hundreds of years, the fuller and larger became the sepulcher and therefore the greater the resurrection, by which I mean more plants and larger plants developed. The process continued until the greater resurrection could be seen in the production of the giant trees, which the pioneers found in this country.

When next you pass through the cuts in the highway or railroad you will watch not only for the stone flour, but you will also watch to see the thickness of the sepulcher, I mean the soil and the plant growth I have spoken of as the resurrection.

LESSON CXXXIII.

THE MIXING OF HUMUS WITH STONE FLOUR.

Purpose.—To teach the pupils to identify humus (organic matter) and to understand the part it plays in fertile soils.

We can make soil artificially. We may bring together the stone flour and vegetable mould and mix them mechanically. You may give an illustration to your class by getting leaf mould from the woods and mixing with it stone flour of sand or of shale rock. If plants had means of expressing in words their sense of comfort, we might learn that the task was done a little clumsily with your hands as compared with nature's way, yet you can demonstrate that plants will thrive better when planted in the mixture than when in stone flour alone. I will say that nature has many ways of mixing the ingredients of the soil, some of which I

mentioned in the October issue. Another one of nature's ways for mixing the two that is of importance is by the hard work of the earth worm. I want to call the attention to this creature's industry in boring into the soil and the small piles of casts that may be found on mornings during summer rains. The earth worm is very low in point of intelligence. He cannot see or hear and has only a dull sense of feeling through nerves, but he has done the world great service by his tremendous industry. Many people both old and young who think their part in life is not worth while because they were not born geniuses may well go to the humble earth worm for a lesson. Some one has said that genius lies in hard work.

In agricultural literature, the organic part of the soil is called humus and because of that we will in the future drop the term organic matter and substitute that of humus. The black muck of the swamp is humus. Because of its having been submerged by water much of the time, it is often different in character from that of leaf mould of the woods. In what I may say concerning humus I shall have in mind woods earth or leaf mould and not swamp muck. Humus, once having had life is perishable and in cultivated lands the depleted stock must be replenished. I wonder if any of the humus that may be found in the soil to-day will be there after seventy-five years of cultivation. One of the first steps in restoring fertility in a "run out" soil is to determine if it has the needed amount of humus. In my orchard of peaches, plums, cherries, and vineyard of grapes, the soil is tilled the summer through and this process of aeration hastens the destruction of the humus in the soil. To make good that loss, I sow what are known as "cover crops" such as rye, or buckwheat, or clover, or hairy vetch, not for the purpose of harvesting, but to plow into the soil that it may rot there and become humus.

In the language of the chemist all the functions of humus "are not fully understood." That it has a sponge-like power to absorb water is demonstrated by the following suggested experiments.

In appearance the soil is a dead or inert mass. Nevertheless, when proper conditions prevail such as heat, moisture, and the proper degree of aeration, it is a very busy place as revealed to us by the chemist and bacteriologist.

At such times plant food is elaborated and made available for the use of the plant. The process of rotting or wasting away of humus is an important factor in getting such results. A cup of dry wheat flour has no energy of itself but when given moisture, heat and yeast, awakens to great activity—in its way as great as that of the county fair on a pleasant Thursday in the month of September.

Do you know leaf mould when you see it? Leaf mould is humus. For identification and a supply go to the woods with a garden trowel. Select some sheltered spot where the wind scattered leaves have found an eddy. Here they have found a resting place for many winters. Brush away the coarse covering and you will find leaf mould immeshed in a net work of roots. It is black and has a velvet like feeling to the touch as compared to gritty sand or rough clay. Take home with you a basket full to demonstrate some of the qualities which it possesses that stone flour does not.

LESSON CXXXIV.

MOISTURE IN SOILS.

Purpose.—To call attention to the fact that soil with humus in it holds much more moisture than inorganic soil.

Experiment.—Kiln dry enough humus to fill a flower pot. Also kiln dry a quantity of sand. This may be done in the oven. This will drive out the moisture and put each on equal footing for comparison in weighing. Fill the flower pot full of the leaf mould. Put the same weight of kiln dried sand in another flower pot. Soak each with water until the surplus runs through the hole in the bottom of the flower pot. Let each pot remain for half an hour that all drainage may escape that will, and then weigh each pot again. Make note of the amount of water the sand and the leaf mould can respectively hold as water is held by a sponge. Note what per cent. of its own dry weight the sand can hold, also the leaf mould. See if you can get the leaf mould to approximate 200 per cent. of its dry weight.

LESSON CXXXV.

CLAY AND SAND.

Purpose.—To determine which will hold the most water, a clayey soil or humus.

Repeat the experiment of the previous lesson substituting clay for sand.

LESSON.

WATER FLOWS UP MORE READILY IN SOME SOILS THAN OTHERS.

Purpose.—To show the relative capillary power of sand and humus.

Experiment.—Fill a lamp chimney with kiln dried leaf mould and another with kiln dried sand. Jar each chimney so that the particles will lie closely together. More attention must be given the leaf mould in this particular than is given the sand. In fact, the former should be crowded into the lamp chimney to have the same close fit between particles

to be equal to the sand. Set the two chimneys in a dish and pour water into the bottom of the dish and note which takes water (up hill) the fastest and which tne highest.

When the upward movement stops in each lamp chimney, weigh and compare with the dry weight. This will determine the power of each to draw water from the water table towards the surface for the use of plants.

How water climbs through sand.

LESSON CXXXVI.

WHY CLAY BECOMES HARD AND BAKED.

Purpose.—To show relative capillary power of clay and humus.

Experiment.—Same as above experiment excepting that you substitute clay for the sand. If cheese cloth is tied over the bottoms of the lamp chimneys, the experiments may be more conveniently done.

LESSON CXXXVI.

WHY CLAY BECOMES HARD AND BAKED.

Purpose.—To show relative capillary power of clay and humus.

Experiment.—Same as above experiment excepting that you substitute clay for the sand. If cheese cloth is tied over the bottoms of the lamp chimneys, the experiments may be more conveniently done.

LESSON CXXXVII.

THE FERTILITY IN THE SOIL.

Purpose.—To teach the pupils how to determine the amount of humus in any soil.

Experiment.—Take samples of soil, one from the garden or other notably fertile plot and another from a knoll where but little is growing but mullein or stunted briars. Kiln dry the samples and weigh, keeping

each weight separate. Place one after another on a fire shovel and put over hot coals and watch the humus burn out, after which again weigh and determine the loss of weight of each. The loss shows the amount of humus each sample contained. Note if the most fertile soil contained the most humus.

A SUGGESTION TO THE TEACHER.

At this point I beg to digress to speak of a particular lesson that I once learned by my failures. Such lessons have happened many times in my life but the one I have in mind has a special significance at this time.

Once upon a time I gave a teacher the foregoing instruction about the structure of the soils and on the strength of what I had told her she proceeded to start a border garden along the side of the house. It was indeed a sad failure for the reason that when the contractor graded the lawn after the house was completed, he dumped all the rubbish such as broken stone, brick, mortar and some of the stone flour that came from the bottom of the cellar at the particular place where my friend wanted some flowers and vines and climbing roses and bulbs to grow. There was little there but inorganic stuff that had never had life. That which came from the bottom of the cellar was more clay than sand or gravel and when dry was hard and would have been a lid to prevent seeds from getting through to the daylight had there been any power in the soil to have given them an impetus to make growth. The plot had stone from the size of a saucer to an assorted lot of buttons. The chief thing lacking was humus. There was nothing but stone flour and poor texture at that. The remedy would have been first to improve the texture by re-spading and taking out the rougher stone and next by adding more humus. The latter should have been done by mixing some well rotted stable fertilizer and then some rotted sods. If some rotted leaves gathered the fall before could have been spaded in with the other additions, the results would have been excellent. All this would have made the soil more friable—if I say mealy you may better understand what I mean. Another important influence was that the humus would hold more moisture and for a longer time. This you cannot fail to appreciate if you have worked out the demonstrations that I have suggested.

The mistake was mine because of faulty teaching. I had given her the why without the how.

There was another garden in the same block with about the same original soil conditions that was a credit to its owner, a woman who had spent her life in humble pursuits. She knew *how* to plant, cultivate and all that, but had no idea *why* she performed the different things. In short she gardened by recipe. I regret to say that far too many expect instructions in that form. The recipe form of teaching is more adapted to cooking when the conditions may be made fairly uniform but such is never the case with plant growth out of doors. Two days may be typical, but I doubt if two were ever exactly alike in all that goes to influence plant growth. Herein lies the advantage of knowing the why as well as the how. The greatest success in plant growth depends on the conjunction of three things,

Doing The right thing
At the right time
In the right way.

To give an idea of conjunction of different events, I have heard it said that if the river Neva should have its greatest flood at the time of the highest tide of the year, and the strongest north wind ever known, the city of St. Petersburgh would be inundated.

I find that in my fruit orchard spraying is a necessity. If I fail to do it at the right time or not in the right way—leave out either or both—my work goes for naught.

The humble woman with the commendable garden will be rewarded for her labors as long as conditions are normal. Her recipe stands her in good stead then but when conditions are abnormal my friend the teacher will have the advantage in knowing the why, for the reason she will know how to modify her methods to the changed conditions.

IN NATURE-STUDY TELLING IS NOT TEACHING.

If a teacher knows a fact in nature's realm she is then in a position to lead her pupil to discover this fact for himself.

Nature-study lessons are far more effective when the pupil is so interested that he is unaware that he is learning a lesson.

Some teachers may give a live nature-study lesson from a stuffed specimen, and some others may stuff their pupils with facts about a live specimen; of the two the former is preferable.

The test of truest success of a nature-study lesson is that it leaves the pupil with a keen interest in the subject. The point of highest interest should follow instead of precede the lesson.

Home Nature-Study Course

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"First Studies of Plant Life," Atkinson.
"Field, Forest and Wayside Flowers," Going.
"To the Dandelion," J. R. Lowell.
"Seed Dispersal," Beal.
"Blossom Hosts and Insect Guests," Gibson.
"Nature's Garden," Blanchan.
"Field Book of American Wild Flowers," Mathews.
"The Child's Own Book of Wild Flowers," Comstock.

HOME-NATURE STUDY COURSE

TEACHERS' LEAFLET.

Based on the work for first and second year pupils as outlined in the Syllabus of Nature-Study and Agriculture, issued by the New York State Education Department.

With this leaflet the work of the Home Nature-Study Course for the current year is completed. The editors have sought to give at least one point of view in method of teaching the topics discussed in these 173 lessons. As nature-study lessons pure and simple, the leaflets for this year have given too much information and have required too little direct observation to be of the highest efficiency. However, this plan has been followed with aforethought, as information lessons were needed by the teachers of the State in order that they might begin at once the work outlined in the State Syllabus. The editors have dared to hope that by this easier path the teacher untrained in nature-study methods may be led to original observation, and to a thorough study of each subject before she presents it to her pupils. In any case, the pupils are so much more interested in direct observation than in mere information concerning animals and plants, that they will naturally carry on the work as original investigation whether the teacher has time to make observations for herself or not.

Photo. by Verne Morton.

The ever triumphant dandelion.

THE DANDELION.

LESSON CXXXVIII.

WHY THE DANDELION IS A SUCCESSFUL WEED.

Preliminary Work.—Perhaps there is no better way of making the pupils interested in this plant than by comparing it with a great silent army of conquest. The dandelion host is working everywhere for possession of the land ,and is contesting every square foot of lawn, grass land, roadside, and meadow with the legitimate inhabitants. Explain the difference in the way of fighting between this invader and the invading armies of men. The dandelion sends its seed out to conquer; each seed has a balloon and the wind floats it away to new territory. Wherever it alights it tries to push its way down into the ground, and as soon as it gets a foothold it crowds out the plants in its neighborhood by taking the food from the soil away from them, and also by stealing their sunlight, with its vigorous rosette of leaves.

Purpose.—To lead the child to think why the dandelion is such a dominant weed.

Encourage the pupils to carefully dig out a vigorous dandelion plant so that they may see how the tap-root goes down deep, so that the plant is able to get both food and water from the soil, which other plants cannot reach with their roots. Note that the dandelion has a rosette of strong leaves, which overlap each other more or less compactly and shades to death the grass or any other plants trying to grow beneath; let them see that this is why the dandelion is able to occupy so much room. Note how early the first blossom appears in the spring and how late is the last blossom in the fall; let the pupils see the significance of this constant effort on the part of the plant to blossom and perfect seed. If they realize that it is through the seed distribution that this plant spreads, they will understand how its almost perennial bloom is of the utmost importance to it. Note that if the dandelion grows in the meadow in the tall grass, it sends its blossom and seed stalk high up to the tops of the grass so that the seeds may sail away over the meadow unhindered; but if growing on the lawn the flower stalks are so short that the lawn mower passes over them without cutting, and the seed will be developed on these low stalks quite as well as on those a foot high. In fact, the lawn mower itself is an agency in scattering the seeds. The summary of this lesson should be that the pupils should draw from their own observations and thinking the following conclusions: The dandelion conquers (a) by producing seed for a long season; (b) by flourishing in very different situations equally well; (c) through ballooning its seeds into new territory; (d) by rooting deeply; (e) by crowding and shading its neighbors out of existence; (f) by forming vigorous leaf rosettes in the fall, which will live safely underneath the snow and enable the plant to begin work very early in the spring.

LESSON CXXXIX.

THE DANDELION BLOSSOM.

Purpose.—To give the pupils an understanding of the structure of the dandelion flower.

This being one of the composite flowers difficult to understand, the children should be taught to regard each blossom as a large family of flowers living together. (See Lessons XXXVI to XL, this series.) Note that in the case of the dandelion each little flower has a banner of yellow, and each flower is perfect and will produce a seed. Let the pupils count how many flowers there are in one family; this number ranges from one hundred and fifty to two hundred usually. Let them note the following things about the flower head: How it looks in the bud; how many of the flowers are in blossom the first day; the second day, etc., covering its history until the blossoms fade; note that it looks like a bud again while the seeds are ripening; note that the blossom heads close on dark days and nights; notice all of the kinds of insects found working on the dandelion, and that these are the pollen carriers.

LESSON CXL.

THE STRUCTURE OF THE DANDELION SEED.

Purpose.—To call special attention to the dandelion seed.

Take several blossom heads which have closed after blossoming but before they have opened as seed heads. Tear one apart and note how the balloons are developing from the blossoms; while it is thus shut up the little stems that hold the seed to the balloon are elongating. Study the opening of the seed head and how long it takes to make a perfect globe. Note that this globe is made by the bending back of the bracts which enfolded the flower and the seed head, and note the different angles of the seeds to the base on which they are fastened. Pull off a single seed and if possible study it with a lens. Note the difference between this and the thistle or a milkweed seed, so that the pupils will understand that the dandelion seed is never at the center of the balloon. Take off the seeds one by one and notice the little pit where each seed was borne; count the seeds and then give an arithmetic lesson. Estimate how much ground is occupied by a vigorous dandelion plant; this would be at least five inches square and might be more. Let them multiply this by the number of seeds in a head, then go out in the yard and measure off the amount of ground that the seeds of one head would cover if they should all gain foothold and grow.

LESSON CXLI.

THE STRUCTURE OF THE DANDELION PLANT.

Purpose.—To call attention to the peculiar leaves and the hollow stem of the flower of the dandelion.

The hollow stem of the blossom head has been a joy to children from time immemorial. It is a trombone which will give to the enterprising teacher a fine opportunity for a lesson in the physics of sound, since by varying the length the pitch is varied. There is also a lesson in mechanics afforded by this stem, which the boys are more likely to teach to the teacher than the reverse; this is the superior strength of the hollow column, a fact utilized in the construction of iron frame work for buildings or the iron frame of a bicycle. The dandelion curls, which the small girls enjoy making, offer another lesson in physics in surface tension, much too hard for them to understand.

Photo. by Verne Morton.

Ready to send off exploring seeds for future conquest.

Have the children carefully draw a single dandelion leaf, showing the peculiar notched edges. Explain that these notches were supposed to look like lion's teeth in profile, and so the plant was called in French, "dents-de-lion," teeth of lion, and thus we have changed the name to dandelion.

References.—"First Studies of Plant Life," Atkinson, pp. 85, 86, 178, 182; "Nature-Study and the Child," Scott, Chapter I, and pp. 381-384; "Field, Forest and Wayside Flowers," Going; "To the Dandelion," J. R. Lowell.

THE VIOLET.

Preliminary Work.—Let the pupils bring in bouquets of any of the wild violets that happen to be common and in blossom. Try to make them interested in finding

as many kinds as possible. In each case they should bring in leaves with the blossoms. Each pupil should have one or more species of violet on his desk before this lesson is given.

LESSON CXLII.

THE VIOLET BLOSSOM.

Purpose.—To call attention to the peculiarities of the flower of the violet.

Note that whatever the color or however different the shape of the blossoms of two species of violets, they resemble each other in the following points: There are five petals, one differing in shape from the others, extending back in a closed tube. Note that always on this lower petal are lines which converge towards the opening of the tube. At the tip end of this tube, which extends back behind the sepals is secreted the nectar. Most children know this from having bitten off the tip of the tube. By the way, this tube is the part which enables the boys to "fight roosters" with these flowers, as it acts as a hook in this unnatural diversion. Explain to the pupils that the nectar is put at the tip end of this tube so that the insects in reaching it are obliged to pass the door where both the anthers and the pistil stand guard, and are thus sure to be dusted with pollen from the former and are likely to deposit it on the latter. Through a lens note that there are five anthers "holding hands" around the entrance of the tube. Get the pupils to note which insects are most active in visiting the violet. Note that the tubes of some species are very short so that the bees are able to reach the nectar; but the butterflies do a large share of the work of pollen carrying for the violets, since the butterfly tongue can be unrolled and pushed the whole length of the tube of even *Viola rostratra,* whose slender spur is longer than its pale, lavender petals. Ask the pupils to look very closely at the base of the violet plants for the little flowers which never open, and which self-fertilized produce seed.

LESSON CXLIII.

THE FRUITING OF THE VIOLET.

Purpose.—To call attention to the seeds of the violet.

This may be done by watching the blossom of a potted violet as the seeds develop. Note that there is a three-lobed pod; that after a time the pod splits into three parts, each section holding several seeds. After a little the sections dry and shrink together, thus pinching the seeds so that they are thrown out. (See "Seed Dispersal," W. J. Beal, p. 59.)

LESSON CXLIV.

THE VIOLET PLANT.

Purpose.—To call attention to the great variation in the shape of the leaves of different species of violets.

This should be a lesson for the cultivation of close observation. As drawing is the best means of knowing whether a pupil sees accurately or not, it would be well for the pupils to draw first, the different shaped leaves that they find on one species of violet, and then make drawings of

Photo. by O. L. Foster.

The violet in blossom.

the leaves of all the other species in the locality. If the pupils are sufficiently skilled in drawing, water color pictures of the different species of violets would prove a most interesting task.

References.—"Seed Dispersal," Beal, p. 59; "Blossom Hosts and Insect Guests," Gibson, p. 16; "Nature's Garden," Blanchan; "Field Book of American Wild Flowers," Mathews; "Nature-Study and the Child," Scott, pp. 613 and 615.

THE HEPATICA.

Preliminary Work.—There should be potted in the schoolroom a vigorous hepatica plant, taken from its place in the woods in the late fall or very early spring. Children are so fond of this favorite flower, that they will watch the development of the blossoms eagerly, and the points in the following lessons may

be discussed while the flowers are lifting up and unfolding and fading. After the flower has been studied it should be cared for until the proper time comes for planting it in some shady spot near the school. The point of interest in choosing a place for this plant is that it needs shade during the heat of the summer, and it may well be the first lesson in teaching the pupils that some plants need constant sunshine, while others cannot endure it.

LESSON CXLV.

THE HEPATICA BLOSSOM.

Purpose.—To call attention to the development of the hepatica flowers.

First note that the blossom buds are cuddled down in the center of the plant and protected by the leaf stems; these buds were formed in the autumn, so as to be ready to stretch up and blossom when the first warmth of spring should reach them. Note that the stems and the bracts in which the flower is hidden are soft and downy. While this down is not for the purpose of keeping the plant warm as furs might keep us warm, yet it acts as a blanket to prevent too rapid transpiration, which is a cooling process. Note that on dark days and during the night the blossoms close until they become old and faded when they remain open all the time. It is an interesting point that these flowers close except at those times when bees would be likely to visit them and thus save their pollen; but after the pollen has been distributed and the seeds fertilized they do not need to remain closed any longer. Ask the pupils if bees and other insects are seen flying during dark days in early spring. Have the pupils make a color sketch of a flower when open, so as to be sure they see accurately the number of petals. A technical fact which the teacher should know, although she may not see fit to confuse the younger pupils' minds with it, is that what we call petals in the hepatica are really delicate, colored sepals; the flower has no petals. The three sepal-like bracts, which enclose the flower in the bud are not sepals, and if you examine them closely you will see that they come off from the stem a little distance down from the flower. Note if all the flowers are the same color, and if they fade as they grow older. Note whether the flowers are more fragrant when first opened than later on, and teach the pupils that fragrance is an attraction to the insects. There is probably little or no nectar secreted in the hepatica. The bees are quite as fond of pollen as they are of nectar, especially after their long winter fast, so it is not necessary for the early spring flowers to secrete nectar in order to entice the insects. The pupils should look through the lens and see the anthers shedding their pollen, and also the pistils at the center of the plant. They should see these so as to be able to watch the development of the seed.

LESSON CXLVI.

THE HEPATICA LEAF.

Purpose.—To call attention to the hepatica leaf.

Note that the leaves which have endured the winter are a beautiful purple-brown. Explain that they did their work for the plant during the autumn after the leaves had fallen from the trees, and thus let in the sunshine power, so that they could perfect the starch and other plant-food for the development of the little flower buds tucked away so cosily at

Hepatica blossoms.

their bases. Note the unfolding of the downy, young, green leaves. Note from what part of the plant they spring, that is, outside or inside the old leaves.

The hepatica leaf is so beautiful in shape that it lends itself readily to decorative purposes. Therefore, instead of having the leaf drawn as a part of the plant, give it to the pupils as a unit for a design of some sort.

LESSON CXLVII.

THE HEPATICA SEED.

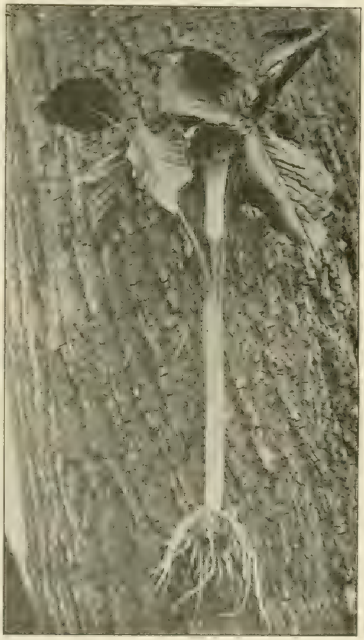
Purpose.—To study the development and distribution of the seed of the hepatica.

As the flower fades keep up the pupils' interest in the developing seed. Note how many seeds are developed. Note that this ripened seed is enclosed and protected by the same bracts which protected the flower. Note that there is but one seed developed in each pistil. If the pupils have access to the woods let them watch how these seeds are distributed. So far as we have observed, they simply fall to the ground when ripe.

References.—"Nature's Garden," Blanchan, p. 17; Cornell Nature-Study Leaflet; "Field Book of American Wild Flowers," Mathews, p. 134; "The Child's Own Book of Flowers," Comstock.

JACK-IN-THE-PULPIT.

Preliminary Work.—A plant should be brought to the school, root and all, so the pupils may see the peculiar shape of the root, and know why it was called Indian turnip as well as Jack-in-the-pulpit. These fleshy roots or corms are very peppery when raw because they are filled with minute, needle-like spicules which become softened through boiling. The Indians boiled these corms and used them for food. The children should understand why this is called Jack-in-the-pulpit. The spathe is the shape of the sounding board, which is placed behind pulpits in cathedrals and old-fashioned churches.



Jack-in-the-pulpit showing corm and rootlets.

LESSON CXLIX.

THE FLOWERS OF JACK-IN-THE-PULPIT.

Purpose.—To make the children familiar with the parts of this plant.

Transplant a Jack-in-the-pulpit as soon as its first points show above the soil and let the pupils note how the leaves are folded about each other in a little cone; one leaflet of the three-parted leaf pointing up and two down. After the leaves unfold so as to show the lower stalks, notice that the tip of the hood is not bent over, but is in a straight, pointed roll; only after it unfolds does the tip bend over Jack. The Jack or the central part in the flower is the club or spadix, around the base of which the flowers are set. Note that the flowers are at the base of the spadix, protected by the tube made by the lower part of the hood. Sometimes the pistillate and stami-

nate flowers grow on separate plants, but sometimes they may be found on the spadix of one plant, the pollen-bearing flowers being set above the seed-bearing flowers. This plant relies largely upon flies to carry the pollen from flower to flower. Make the pupils understand that the spathe or hood is not the flower any more than the blanket is the baby; it is simply a protection for the flowers and an assistance in getting them fertilized.

LESSON CL.

THE PLANT AND FRUIT OF JACK-IN-THE-PULPIT.

Purpose.—To call attention to the peculiarities of the leaves and the fruit of the Jack-in-the-pulpit.

Note that on some plants there are two leaves, on others only one. Note that the leaf is divided into three leaflets. Make a drawing of the leaves, showing the peculiar venation. Note that later in the season the leaves die down as the fruit develops. The fruit at first consists of a bunch of green berries, but later turns a vivid red, remaining thus until the frost comes.

References.—Cornell Nature-Study Leaflets; "Ten New England Blossoms," p. 61; "Nature's Garden," p. 365; Poems by John G. Whittier and Lucy Larcom; "First Studies of Plant Life," Atkinson, p. 166; "How to Know the Wild Flowers," Dana, p. 324; "Blossom Hosts and Insect Guests," Gibson, p. 111; "The Child's Own Book of Wild Flowers," Comstock.

THE CABBAGE BUTTERFLY.

Preliminary Work.—This is a most excellent object for insect study as it is easily procured. It is better to begin with a butterfly, as the pupils are usually more interested in butterflies than in the caterpillars. A butterfly may be captured and kept in the schoolroom, letting it fly about upon the windows, so that the children may become familiar with it. Then tell them the story of the way this insect came from Europe and drove from America all of our native cabbage butterflies, so that now these native species only live in out-of-the-way places and upon wild plants. It first appeared in Quebec in 1860, and in 1868 appeared in New York. Perhaps butterflies chanced to come independently to these two places as stowaways upon ships from Europe. From these points the cabbage butterfly, in a little more than twenty years, spread from the Atlantic to the Pacific and from the Gulf of Mexico to Hudson Bay. It is an instance which shows the fact that if plenty of food and no enemies confront a species, it multiplies and spreads almost beyond computation.

LESSON CLI.

THE WHITE BUTTERFLY.

Purpose.—To make the children familiar with the cabbage butterfly and enable them to distinguish it from other species.

The males and females may be distinguished easily from the fact that the mother butterfly has her front wings ornamented with a black tip and two black spots upon each; while the father butterfly has the front wings black tipped and with only one spot near the middle of each wing; both have black spots near the front margins of the hind wings. The only species of butterfly which is likely to be confused with this is the yellow roadside butterfly, and it would be well to have one of these butterflies in the room to compare with the cabbage species. Note that the roadside butterfly is almost always bright sulphur yellow and has a black border to both front and hind wings; this black border distinguishes the species at a glance.

If the butterflies be kept at large in the room or in a cage, the children should observe a few things about them. Note the eyes and knobbed antennæ; note on what portion of the body the six legs are fastened, and especially note the coiled tubular tongue. If flowers with nectar are introduced into the room, the pupils may see the butterflies uncoil this long tongue in search of sweets. If there is a compound microscope available, it will afford the children the greatest amount of pleasure to look at a bit of a butterfly's wing under a three-fourths objective. This will show the coverings of the wings to be scales lapped like the shingles on a roof. See " How to Know the Butterflies," p. 16.

LESSON CLII.

THE EGGS.

Purpose.—To reveal to the pupils the beauty of form and of color of a butterfly egg.

This is a study that must always be made with a compound microscope, but it will repay the trouble. To get the eggs a mother butterfly should be placed in a cage with a bit of cabbage leaf and she will in all probability soon deposit her eggs. The egg to the naked eye looks like the tiniest speck of yellow; it is jug-shaped and is usually laid on the under surface of the leaf; it is yellow and has about a dozen lengthwise ribs, which in turn are cut across by depressions. See " How to Know the Butterflies," plate 3.

LESSON CLIII.

THE CATERPILLAR.

Purpose.—A study of the caterpillar and its habits.

Material.—A cabbage butterfly caterpillar is perhaps one of the very best for study in the schoolroom. All that is needed for its food is a cabbage plant or a cabbage leaf, which should be replaced as often as it becomes wilted. The caterpillars may be found in almost any

cabbage patch and they will live contented on the leaves brought into the schoolroom. They should be placed in a box with a cover of wire or cloth netting, or what is better in a glass breeding cage, where the pupils may be able to observe them constantly.

The caterpillar is green and downy and so much the color of the cabbage leaf that it often escapes observation. It is velvety looking and in that way resembles the cabbage leaf. It grows as do all caterpillars by shedding the skeleton skin as often as it becomes too tight. Let the children note something of its structure when studying this insect. Note that there are six true legs, two on each of the three segments just behind the head. Notice that these are little, sharp-hooked feet and look very different from the fleshy legs on the rear of the segments of the body which are merely fleshy prolongations of the segments to help hold the caterpillar on the leaf. Note that the breathing pores can well be seen along each side, one on a segment. These holes open into the respiratory tubes and enable the insect to breathe. Be sure and impress upon the pupils that the insects do not breathe through their mouths as we do. Note especially that the insects use their mouths only for eating and that they have no one organ for smelling comparable to a nose. For the way the insects breathe see "Manual for the Study of Insects," p. 73.

LESSON CLIV.

THE CHRYSALIS.

Purpose.—To interest the pupils in the way the caterpillar suspends itself and changes to a chrysalis.

The caterpillars that have become fully grown in the breeding cage will wander off to the sides of the box and there remain quiet for some time. A caterpillar acting thus should be watched very closely. First it will spin a button of silk in which the hooks on the rear end of the body may cling; it then will spin a loop just a little forward of the middle of the body, which serves to hold the body next to the object on which the transformation is taking place. Then the skeleton skin is shed and pushed back and off. The halter or loop holds the chrysalis in place while it pulls itself out of the old skin and fastens the hooks at the tip end into the button of silk. Note that the chrysalis is angular and is very likely to be similar in color to the object against which it is hung. This protects it from the keen eyes of birds. Let the pupils note the wing pads, and if possible have them see the butterfly emerge from its chrysalis. Call attention to the fact that there is no cocoon made to protect the pupa or chrysalis of butterflies. This is one important difference that distinguishes the pupæ of butterflies from those of moths.

References.—" Everyday Butterflies," Scudder; " Manual for the Study of Insects," Comstock, p. 73; Cornell Home Nature-Study Leaflets, No. 3, 1905; " How to Know the Butterflies," Comstock, p. 16; " Nature-Study in Elementary Schools," Wilson; " Nature-Study and the Child," Scott, pp. 434-435.

THE COW.

Preliminary Work.—The fact that our milk, butter and cheese as well as our beef are all provided by the cow, is sufficient to make the pupil interested in this useful animal. But all of these useful products hardly appeal to the imagination of the child accustomed to the domesticated animal. Probably the subject will be far more interesting if taken up in another phase,—that of regarding the horned cattle as wild animals, and trying to understand their physical adaptations for leading successful lives in droves on the great plains. Therefore, it will be well to begin this work with stories of buffaloes and wild cattle. Interesting stories of this kind are found in " Neighbors with Claws and Hoofs," pp. 171-181; also the exciting story of Shere Khan in " The Jungle Book," by Kipling; The Alien of the Wild in " Watchers of the Trail;" also " A Country Reader," p. 37. Bring out the point that wild cattle ranging the plains have for their chief enemies the wolves. When attacked by a pack they place the calves in the center, while the cows and bulls form a circle with heads out and horns ready and no possible chance for a rear attack. The teacher of resource might be able to suggest a play called " Wolves and Cattle," which would be very interesting. If the pupils are from the farm they will know that in many instances if a calf is born in the field the cow will hide it and the calf will never stir until an attempt is made to seize it. Bring out the fact that this habit is of great use to a cow in the wild state, when it is necessary for her to go off and graze in order to get sustenance enough for her calf.

A good dairy cow.

LESSON CLV.

THE PHYSICAL ADAPTATIONS OF HORNED-CATTLE.

Purpose.—To call the attention of the pupils to those characteristics of cattle, which enable them to get their living and repel their enemies in the wild state.

The food of cattle naturally is grass and herbage. Notice that their teeth are so arranged that they pull grass off instead of biting it as does the horse. Get the pupil to note the peculiar movement of the head of the cow when she is grazing, and he will see that she seizes the grass between her lower front teeth and the pad on the front of the upper jaw and pulls it off. There should follow a little talk on the stomach of the cow; for picture and description see "Country Reader." Pupils from the country are familiar with the process known as chewing the cud. Get them to understand the advantage of this habit to the cow, as she does the work of grazing during the cool of the morning and evening, and is able to lie down in the shade or near some water course and chew the food which she has gathered and digest at her leisure. Let them observe at what time of day the cows do their grazing in hot weather. If possible let them observe how the cow makes constant use of her sense of smell both in sniffing food before she eats it and in sniffing danger. Let them note that the eyes of the cow are large and beautiful; that the ears can be moved back and forth, so as to be ready to receive sound in any direction; note that when startled she faces the disturbance with ears spread wide and with nose lifted, so as to get all the news possible of the danger. Note that her horns are naturally strong and sharp; she not only gores her enemy, but will also toss him if she is strong enough. Note that the heavy head and neck and short heavy horns of the bull are not so much for defense against enemies, as for fighting between rivals. Tell the pupils that almost any man or animal attacking cattle is more afraid of the horns of the cow and the fierceness of her attack than the attack of the bull. Note that the bull will also stamp upon his enemy if possible; note that all cattle are able to kick very hard if attacked from behind. Have the pupils observe how cattle attack dogs or guard against them when they pass through the pasture. This is explained by the fact that the dog is a relative of the wolf, which is the ancient enemy of cattle. Note that the foot of the cow is different from that of the horse. She walks on two toe-nails instead of one; note that there are two toes which are not now used, which are called "dew-claws." This means that in ancient times the cow walked on more toes than at present. Explain that the split hoof is a great advantage in the wet and swampy margins of still-flowing streams, which characterize the water courses of the great plains, and through which the cattle must pass to drink. A horse would become mired in mud from which a cow can easily extract her feet. Note the use of the tail to brush off flies; explain that flies of different kinds, like the horn-fly and bot-fly and others are among the greatest enemies of cattle. Note that the cow's udder is larger than that of the horse or any other animal. This has to

do with the habit the young calf has of lying still while the cow goes away to graze; this renders the large udder necessary in which to store the milk of several hours making and is correlated with the large stomach of the calf, which will contain an udderful at a meal. This peculiarity of feeding her young is what has made the cow so useful to man as a milk giver. See "Country Reader." Note that the covering of the cow is short, stiff hair; note also that if cattle are left out of doors during the winter this hair becomes shaggy and unkempt; it seems to be a natural way of providing warmth, and the same is true of the horse. Read the excellent chapter on Wild Cattle in the Life of Animals, Ingersol, pp. 234-251.

LESSON CLVI.

THE USEFULNESS OF CATTLE.

Purpose.—To make the pupils understand the importance of cattle to mankind.

When man emerged from the savage state his first step toward civilization was domesticating wild animals and training them for his own use. During the Nomad stage when tribes wandered they took their cattle along. See Bible stories. From the first these animals have been used in three capacities: First, for carrying burdens and as draught animals; second, as meat; third, as givers of milk. They were also used in the earlier ages as sacrifices to the various deities.

As beasts of burden and draft animals the oxen are used still in many parts of the United States. For logging especially oxen are far more valuable than horses. They are patient and will pull a few inches at a time if necessary, a tedious work which the nervous horse refuses to endure. Cows, too, have been used as draft animals and are so used in China to-day where they do most of the plowing; in these oriental countries milk is not consumed to any extent, so the cow is kept for the work she can do. In ancient times in the East, white oxen formed a part of the royal processions.

LESSON CLVII.

MILCH AND BEEF-CATTLE.

Purpose.—To teach the pupils to recognize some of the chief breeds of cattle and to know the good points of each.

Because of two main uses of cattle by civilized man he has bred them in two directions, one for producing beef and one for milk. The beef cattle are chiefly Aberdeen-angus, Galloway, Short-horn or Durham, Hereford and Sussex; the dairy breeds are the Jersey, Guernsey, Ayrshire, Holstein-Frisian and Brown Swiss. The beef animal is in cross section approximately square, being big and full across the loins and back; the shoulders and hips covered heavily with flesh; the legs

Cattle of the beef type.

stout; the neck thick and short and the face short. The line of the back is straight and the stomach line parallel with it. Very different is the appearance of the milch cow. Her body is oval instead of being approximately square in cross section. The outline of her back is not straight, but sags in front of the hips which are prominent and bony. The shoulders have little flesh on them, and if looked at from above her body is also wedge shaped widening from shoulders backward. The stomach line is not parallel with the back bone, but slants downward from shoulders to the udder. The following are the points that indicate a good milch cow: Head wide between the eyes, showing large air passages and indicating strong lungs. Eyes clear, large and placid, indicating good disposition. Mouth large, with a muscular lower jaw showing ability to chew efficiently and rapidly, and the neck should be thin and fine showing veins through the skin. Chest deep and wide, showing plenty of room for heart and lungs. The abdomen should be large but well supported and increase in size toward the rear. The ribs should be well spread, not meeting the spine like the peak to a roof, and the spine must be prominent revealing to the touch the separate vertebræ. The hips should be much broader than the shoulders. The udder should be large, the four quarters of equal size and it should not be fat. The "milk veins" which carry the blood from the udder should be large and crooked, passing into the abdomen through large openings. The skin of the cow should be soft and pliable and covered with fine, oily hair showing a good digestion and assimilation. Above all the milch cow should always be hungry, for she is a milk making machine, and the more fuel (food) she can use, the greater her production.

The physiological habits of the beef and milch cattle have been changed as much as their structure. The food given to the beef cow goes to make flesh; while that given to the milch cow goes to make milk, however abundant her food. Of course, there are all grades between the beef and the milch types, for many farmers use their herds for both. However, if a farmer is producing milk it pays him well to get the best possible machine to make it, and that is always a cow of the right type.

LESSON CLVIII.

A GEOGRAPHY LESSON.

Purpose.—To make the pupils familiar with the agricultural conditions in the countries where these best breeds of cattle have been developed.

All the best breeds of cattle have been evolved in the British Isles and in Europe north of Italy and east of Russia. All our domesticated cattle were developed from wild cattle of Europe and Asia. The cattle which roam in our rapidly narrowing grazing lands of the far West are European cattle. America had no wild cattle except the buffalo. In Geography Supplementary readers, read about Scotland, England, The Channel Islands, The Netherlands, France and Switzerland, and the different kinds of cattle developed in these countries. See A Holland Dairy in "Northern Europe," Ginn & Co.

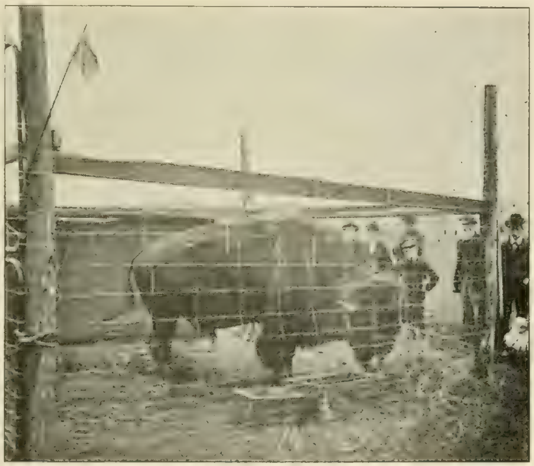


Photo. by Verne Morton.

A specimen of America's wild cattle.

References.—"The Country Reader." "Agriculture for Beginners." "First Principles of Agriculture."

LESSON CLIX.

HOW TO PRODUCE MILK.

Purpose.—To teach about the proper care to be given cows for production of milk.

There are three main ingredients of milk—fat, curd and ash. The fat is for the purpose of supplying the animal with fat and we make it

into butter; the curd supplies muscle and the lean meat of the animal and is the main ingredient of cheese, although cheese to be good should contain a full amount of butter fat; the ash which may be seen as residue when milk is evaporated builds up the bone of the animal. The best butter cows are those which give a large per cent. of fat and a small per cent. of curd, like the Jerseys; the best cheese cows are those which give a fair per cent. of fat and a larger yield of curd, like the Ayrshire and Holstein.

A cow to pay her way in producing cheese should give at least five thousand pounds of milk per year, and she is not a profitable cow unless she gives seven thousand pounds; a butter cow, a Jersey for instance, should produce five thousand pounds of milk per year to be really profitable.

The stable where milch cows are kept should be thoroughly cleaned before each milking and should be swept each day; the cows' udders should be brushed and the milkers should wear clean aprons and should wash their hands before milking. Milk should never be strained in the barn, but in some place where the air is fresh. If milk is perfectly clean, it will keep sweet much longer; sterilized milk put in bottles will keep sweet for weeks and even months. Loud talking should not be permitted in the stables while the cows are being milked, and each cow should be milked by the same person for the entire season.

Every child should know that milk to be legally sold in New York State must possess 3 per cent. of butter fat. For upper grades or first year work in the high school there could not be a more profitable exercise than teaching the pupils the use of the Babcock milk tester. Read Milk and Its Care in "Agriculture through the Laboratory and School Gardens," Jackson and Dougherty.

LESSON CLX.

THE CARE OF THE MILCH COW.

Purpose.—To teach the pupil the proper care of the cow.

The importance cannot be over-estimated of teaching the pupils in rural districts the proper care of cattle for the production of milk. The milch cow is a perfect machine and should be regarded as such in producing milk. First, she should have plenty of food of the right kind, that is, a well balanced ration. Second, she should have a warm, clean stable and be supplied with plenty of good, fresh air. A cold stable makes it necessary to provide much more food for the cow; a case on record shows that when a barn was opened up in cold weather for necessary repairing, the amount of milk from the cows stabled in it decreased 10 per cent. in twenty-four hours. There should be a pro-

tected place for the cattle to drink if they are turned out of the barn for water in winter; it is far better to have the water piped into the barn. A dog should never be used for driving cows. To be profitable a cow should give milk ten months of the year at least. Calves should be dehorned when they are a few days old by putting caustic potash on the budding horns, thus obviating the danger of damaging a cow by dehorning.

In a properly run dairy a pair of scales stand near the can for receiving the milk, and as the milk from each cow is brought in it is weighed and the amount set down opposite the cow's name on a "milk sheet," that is tacked on the wall near by. At the end of each week the figures on the milk sheet are added, and the farmer knows just how much milk each cow is giving him and whether there are any in the herd which are not paying their board.

References.—"Agriculture for Beginners," Burkett, Stevens & Hill, p. 216; "First Principles of Agriculture," Vorhees, pp. 117-197; "Elements of Agriculture," Sever, p. 57; "Elements of Agriculture," Shepperd, chapters 15 and 22; "First Principles of Agriculture," Goff & Maine, pp. 154-176; "Agriculture Through the Laboratory, School and Garden," Jackson & Dougherty, chapter 8; Junior Naturalist Monthly No. 5, College of Agriculture, Cornell University; "The Dairy Herd," Farmers' Bulletin No. 55, U. S. Dept. of Agr.; "Care of Milk on the Farm," Farmers' Bulletin No. 63, U. S. Dept. of Agr.; "Rural School Agriculture," Hays, p. 96; Longman's "Ship" Literary Reader III, pp. 102 and 106; Murche's Science Reader VI, p. 202, "Northern Europe."

SHEEP.

Preliminary Work.—This lesson should not be given unless there are sheep in the vicinity that may be studied. Perhaps the most natural way of arousing interest in the sheep is to tell the stories of wild sheep; that these animals to-day live on high mountains where there is scanty herbage; however, they live in more open places than those frequented by the mountain goat. When the flock rests a sentinel is placed to watch for wolves or other enemies. Sheep live naturally in high altitudes, but during the lambing season they come down to lower and warmer situations. When attacked by enemies their method of escape is not in a straight away race, like the deer, but in following the leader to all sorts of difficult mountain places. Thus the instinct of following the leader blindly is the salvation of the individual sheep. Consult "Camp Fires of a Naturalist," p. 134; "A Country Reader," p. 98.

LESSON CLXI.

THE PHYSICAL ADAPTATIONS OF THE SHEEP.

Purpose.—To teach the pupil to think how the form of the sheep is adapted to its life as a wild animal.

In one respect the wild habit still persists with our sheep, for many of them are able to get their living on poor soil where a cow would starve. They eat the grass much more closely than do cows. Let the pupils look at the teeth of the sheep and see how they are fitted for cropping very closely the grass and the tough weeds. The legs of the sheep are short and small, and it has cloven hoofs, like the cow. However, the upper part of the leg is much developed to fit the animal for leaping. Note that the lamb's legs are very long in proportion to its body, and this is because the lamb must follow the flock in times of danger. The senses of smell and hearing are acute in the sheep. Let the pupils study carefully the eye of the sheep and note how it differs from that of the cow. The fleece of wool is the most marked characteristic of the sheep, and is especially adapted for protecting its wearer from the cold of high mountain climates. Note that we shear off the wool in the early summer, which is a great relief to the sheep in our climate, and furnishes us with clothing as well. If possible the teacher should read "The Flock," a volume written of the sheep and their herders in the far west.

LESSON CLXII.

THE HABITS OF SHEEP.

Purposes.—To call attention to some of the interesting habits of sheep.

Lambs have two games which they play untiringly; one is the regular game of "follow my leader," each one striving for the place of leader. Note that in playing this they run in most difficult places, over logs and stones and across brooks; thus it is a training for the later life when to follow the leader may save the flock. The other game is peculiar to stony pastures. A lamb will climb to the top of a boulder and its comrades will gather around and try to butt it off; the one which succeeds in doing this climbs on the rock and is "it." Sheep not only escape from enemies by jumping and climbing in difficult places, but they also fight by butting with their hard heads and horns. Let any pupil in school who has had experience with a cosset lamb, which almost invariably gets cross as it grows older, relate his experience. The great horns on the heads of wethers were probably developed quite as much for fighting each other as for fighting the enemy. Note that we cut off the lamb's tail so that later it will not get completely filled with burrs and filth. In southern Russia a breed of sheep has been developed with a large, flat tail, which is considered a great table delicacy. This tail becomes so large and heavy that a small cart is fastened under it so that it is supported on wheels and trundles along behind its owner.

The dog, as descended from the wolf, is the ancient enemy of sheep, and even now after hundreds of years of domestication some of our dogs will chase and kill sheep. The Collie or Shepherd dog has been bred so many years as a caretaker of sheep, that a beautiful relationship has been established between these dogs and their flocks.

Supplementary Reading.—"The Flock," by Mary Austin; "A Country Reader," p. 131; Wully in "Wild Animals I Have Known;" "Bob Son of Battle."

LESSON CLXIII.

THE BREEDS OF SHEEP.

Purpose.—To make the pupils familiar with the different breeds of sheep.

This lesson should be based upon such breeds as are raised in the neighborhood or as are exhibited at the county fairs. The two special products of sheep are mutton and wool, and sheep have been bred for perfecting both products. The Merinos have the most beautiful wool, which is long and fine, but their flesh is not so desirable. English sheep are the most popular in America. For the breeds of sheep peculiar to the British Isles see "A Country Reader," p. 106. Get the pupils to read the many interesting stories of our famous wild sheep of the Rocky Mountains.

References.—"American Animals," p. 61; "Familiar Animals," p. 178; "Camp Fires of a Naturalist," Chapter IX; "The Watchers of the Trails," p. 3; "Lives of the Hunted," p. 17; "The Mountains of California," p. 300; "Neighbors with Claws and Hoofs," p. 184; "A Country Reader," p. 98; "The Flock;" Longman's "Object Lessons," p. 62; "Agriculture for Beginners," Burkett, Stevens & Hill, p. 197; "The Life of Animals," Ingersoll, pp. 251-257; "First Principles of Agriculture," Voorhees, p. 197; "Elements of Agriculture," Shepperd, chapter 17; "Sheep Feeding," Farmers' Bulletin No. 49, U. S. Dept. of Agr.; "First Principles of Agriculture," Goff & Mayne, pp. 183-188; "Wild Animals I Have Known," Thompson Seton.

THE DEER AND ITS RELATIVES.

Preliminary Work.—It is rather unfortunate that most of the literature about these beautiful creatures has to do with hunting and killing them. It might be well to begin this work with a geography lesson, showing where the varieties of American deer live. For description of species see "American Animals," pp. 31-54. In general we have four kinds of deer and closely allied animals: The Elk, the Virginia Deer, the Mule Deer, the Moose, and the Woodland Caribou. The Virginia deer is the species which roamed New York State in pioneer days. If there are

any sons of pioneers still living in your locality, you will undoubtedly be able to get some interesting stories about these animals, that will give the pupils a special interest in them. The lesson should not be given unless the pupils have had an opportunity to see the animal.

LESSON CLXIV.

A DEER'S PHYSICAL ADAPTATIONS.

Purpose.—To study the deer's adaptations to its life.

Its food is grass or the foliage of young forest trees. In New Hampshire now the deer are preserved and have become so numerous that they roam out of the forests and destroy the forage crops of the farmers. It would be well to compare the deer with the cow in studying its form. Note how much longer in comparison to the body are the legs of the deer than are those of the cow. Bring out the fact that the deer run very fast and make great leaps to escape from enemies; the enemies are the wolves, panthers, and other large cats, and wolverines. When brought to bay the deer have two ways of fighting; by striking with the head and horns, and by stamping with the feet. Note that it is the males that have the large, branched horns. Explain that these horns are shed once a year and that the new horns develop rapidly. They are at first full of blood vessels and soft and covered with what is known as "velvet." Each year the horns are more and more branched and this indicates the age of the animal. When running, the tail is lifted, showing the white cushion of hairs which surrounds it; this is used as a signal to keep the herd together when escaping by flight. The deer has very acute sense of smell and of hearing. The ears are large, the eyes are beautiful, soft and gentle. The foot has the split hoof, like that of the cow and sheep. The fawns are spotted with white, which is a protecting color in the forests where sunshine filters through the trees.

As much of the study of the deer must be done from books, it would be well to let part of this work be an exercise in English on one of the following themes: The autobiography of a deer which lived in this place one hundred and fifty years ago. An account of the deer preserves in New York State and the game laws relating to deer.

Supplementary Reading.—"American Animals," p. 31; Forest, Fish and Game Reports; "Familiar Life of Field and Forest," p. 235; "Wilderness Ways," p. 1; "Secrets of the Woods," p. 128; "Ways of Wood Folk;" "Northern Trails," p. 162; "School of the Woods," pp. 253 and 287; "Popular Science Reader," p. 314; "Camp Fires of a Naturalist;" "Watchers of the Camp Fire," p. 31; "Kindred of the Wild," p. 287; "The Watchers of the Trails," p. 311; "Forest Neighbors," p. 201; "Animal Heroes," p. 321; "Neighbors with Claws and

Hoofs," pp. 203-215; "The Life of Animals," Ingersoll, pp. 298-333; "The Trail of the Sandhill Stag," Thompson Seton; "The School of the Woods," Long, pp. 253-287; "Wilderness Ways," Long, p. 91; "Forest Ways," Hulbert, p. 201; "Lives of the Hunted," Thompson Seton; "Neighbors with Claws and Hoofs," Johonnot, pp. 203-215.

THE ROBIN.

Preliminary Work.—There is one time of year when all of us in northern climates are especially interested in the robin, and that is when it first appears in the spring. If we begin then to study the bird, the children will require no outside stimulant. While in the lower grades the observations should be a matter of conversation with the teacher, in the upper grades they should form the basis for notes in the field notebook. Some of the pupils at least will become interested in writing a story of some particular robin or pair of robins; as soon as the nests are begun the individuals are easily identified and, therefore, the notes should be made with accuracy. Few of us have any definite idea of the every year repeated story of the robin's nest; therefore, let this be an effort for definite knowledge. If the pupils have no note-books they may be made out of blank paper with a robin pictured on the cover. If possible, let the pupils color this picture from observing the bird. The following is the sequence of observation for such a note-book:

LESSON CLXV.

THE ROBIN NOTE-BOOK.

Date of first appearance in the spring. Describe colors of head, eye, beak, wings, tail, breast, legs, feet. When on the ground does it run or hop. What does it eat when it first comes in the spring? Call attention to the fact that it lives upon Virginia Creeper berries and other berries of this sort until the frost is out of the ground, so that it is able to get at the earth worms. Where do the robins spend the winter? The robins winter in our Southern States, the Gulf States especially, in large flocks. Sometimes robins stay in New York all winter if they succeed in finding food, that is, winter berries, etc. The male robins appear first; note that they do not sing until the females come. Note the difference in color between male and female; she has not the black head and is duller in color. Note how early the robins sing in the morning and how late in evening. The date of beginning the nest. What are the first suggestions in the construction of the nest? Note when the plastering of the nest with mud is done and how it is done. Do both birds build the nest? How long after the nest is begun before the first egg is laid? Describe the eggs. Do both parents take turns at sitting? Does the mother or father bird stay on the nest at night? The date when the first birdling hatches. Do both parents feed the young birds? How and what do they

feed them? Describe carefully how the robin listens for an earth worm and pulls it out. Does each pair of robins have a territory of their own for hunting earth worms? The editor has observed carefully for many years the robins which build around her home, and she is of the opinion that each pair has its own hunting ground, which is not infringed upon by others. Note the date when the first bird comes out of the nest. Note its irregular flight and lead the pupils to see that this is caused not only by half-grown wings but also by lack of a tail to steer with. Note how long the parents continue to feed the robins after they leave the nest. Describe the colors of the full fledged young robin and compare with those of the parents. Note that the spotted breast of the young shows the robin is allied to the thrushes. If the robins raise a second brood do they use the same nest? Usually the nest becomes so infested with bird lice that it is not used a second time in the same season. The note-book should be completed during the summer months with special attention to the time when the birds moult, and should also contain mention of the appearance of the robins in the fall and their final disappearance from the locality. Notes should be made on the robin's songs, of which he has several quite distinct. Note how the robins scold cats, and the peculiar low squeak they make when hawks or crows are in sight.

References.—" Birds in Their Relation to Man," Weed & Dearborn, p. 90; Bulletin, " The Food of Nestling Birds," U. S. Dept. of Agr.; " The History of the Robins," Trimmer; " Bird Life," Chapman; " Field Book of Wild Birds and Their Music," Mathews; " Birds Through an Opera Glass," Merriam, pp. 4-10; " True Stories of Birds," Miller, pp. 37-44; Longman's " Ship," Literary Reader III, p. 110. Field Book of Wild Birds and Their Music, Mathews, p. 248.

THE BLEBIRD.

Preliminary Work.—Probably no bird note is so fraught with the essence of springtime as is that of the bluebird. Its song and its exquisite colors render the interest of the child in the bluebird as fresh and certain as is his interest in the spring. This natural interest may be augmented by teaching the pupils how to build boxes for the bluebirds to nest in and thus secure them for neighbors.

LESSON CLXVI.

THE BLUEBIRD NEST.

Purpose.—To make the pupils acquainted with the nesting habits of the bluebird and methods for enticing it to nest near their houses.

The bluebirds usually build their nest in a hole in a tree or post; they make it of grass and place it ordinarily within ten or fifteen feet of the ground. An old apple orchard is a favorite building site.

A cavity about ten inches deep and six inches in height and width will give a pair of bluebirds room for building a nest. The opening should not be more than two or two and one-half inches in diameter and there should be no threshold; this latter is a very particular point. If there is a threshold or place to alight upon the sparrows are likely to dispute with the bluebirds and drive them away, but the sparrow does not care for a place which has no threshold. The box for the bluebird may be made out of old boards or may be a section of an old tree trunk; it should be fastened from six to fifteen feet above the ground, and should be in nowise noticeable in color from its surroundings. To protect the nest from cats barbed wire should be wound around the tree or post below the box. If the box for the nest is placed upon a post the barbed wire will also protect it from the squirrels.

LESSON CLXVII.

A STUDY OF THE BLUEBIRD'S COLORS.

Purpose.—To make the pupils observe carefully the colors of the bluebird and learn to distinguish the sexes and also to distinguish the bluebird from the indigo bird.

This should be an observation lesson suggested a week ahead of the conference. The points to be observed are, the head, back, wings and tail are blue, the breast red, the under parts whitish; that the mother bird is duller in color, grayish-blue above, and with breast paler. Because of the red breast the pupils will naturally compare it with the robin. It is well to carry on this comparison with the young birds, for the nestling bluebirds have the back spotted with white, and the breast and throat whitish mottled with brown. It is an interesting fact that when our Pilgrim fathers landed in America the bluebird made them think of the English robin and they called it the "blue robin."

LESSON CLXVII.

THE HABITS OF THE BLUEBIRD.

Purpose.—To call the pupils' attention to the habits of the bluebird and to teach them how valuable it is to farmers and fruit growers.

The bluebird, like the robin, winters in flocks in the Southern States. Unlike many of the other birds, the bluebird carries its beautiful song south with it, and its soft, curling note may be heard in almost any part of the Gulf region during winter. The food of the bluebird consists of caterpillars, ground beetles, grasshoppers, crickets and moths. In winter its food is largely wild berries, especially the berries of the mistletoe.

It is of special value to the farmer because of its destruction of cutworm caterpillars and destructive grasshoppers. These make up nine-tenths of the bluebird's food in September. For importance of bluebirds to agriculture see U. S. Department Bulletin, "Some Common Birds in Their Relation to Agriculture," Beal; "Birds in Their Relation to Man," Weed and Dearborn.

References.—Bulletin, "Some Common Birds in Their Relation to Man," U. S. Dept. of Agr.; Bulletin, "The Food of Nestling Birds," U. S. Dept. of Agr.; "Birds in Their Relation to Man," Weed and Dearborn, pp. 86-88; "Nature-Study and Life," Hodge, chapters 18-21; Junior Audubon Leaflets; "Birds of Eastern North America," Chapman, 9, 403; "Field Book of Wild Birds and Their Music," Mathews, pp. 251-254; "Nature-Study in Elementary Schools," Wilson, p. 188; "How to Attract the Birds," Blanchan; "Nestlings of Forest and Marsh," Wheelock, pp. 62-89; "Bird Neighbors," Blanchan.

THE BLUEBIRD.

Winged lute that we call a bluebird,
You blend in a silver strain
The sound of the laughing waters,
The patter of spring's sweet rain,
The voice of the winds, the sunshine,
And fragrance of blossoming things.
Ah! You are an April poem,
That God has dowered with wings.

—*Rexford.*

THE APPRENTICE CLASS IN GARDENING.

JOHN W. SPENCER.

In teaching children gardening I would divide the instruction into three divisions, viz.:

Apprentice Gardening.
Journeyman Gardening.
Master Gardening.

The purpose of this article is to give instruction to teachers that they may help the children in the lower grades to begin a familiarity—an acquaintance—with the growth of plants.

A young duck knows how to swim the first moment it drops into water. I am not sure but that he is as capable at that moment as after years of experience.

A knowledge of how best to help plants to grow is different. It is more like climbing a mountain—taking a step at a time. But begin stepping early in life and then keep on stepping.

An apprentice gardener.

Early familiarity with plants counts for much—perhaps as much as early music and dancing lessons. As a farm boy I cannot recall when I did not know about some certain thing relating to the soil and vegetation. Such early knowledge, to some extent, disqualifies one as a teacher for the reason that one assumes that others have had the same advantages, and to mention some familiar but fundamental points would be threshing old straw.

In the December issue, I said something about motherhood of plants. I did not intend that article as one of pleasing speculation, but rather to help you to get the point of view of the plant. I tried to lead you to understand that the impulse of motherhood was strong, that the plant would in the beginning endeavor to overcome all obstacles and make the most of its life. Circumstances often impose conditions on plants in their growth that they are helpless to overcome. They do not thrive any more than you or I would if we were thrust under water or clapped into a crematory.

I ask that you write on the tablets of your memory this fact that because of the impulse of motherhood each plant wants to grow and become the best plant of its kind that ever grew, so that it may in time become the founder of a new and prosperous colony. The help that plants require of you towards their success is to make them comfortable. I wish you would write upon the blackboard for the benefit of your pupils these lines:

All plants want to grow.
They ask that they be made comfortable.

This statement may simplify what has seemed like a problem full of complexities and vagaries—the growth of plants. The remark is often heard that "plants never do well for me," implying that plants with some people have sulky moods and do not try to do their best as I have said they would.

LESSON CLXIX.

THE WATERING OF PLANTS.

Purpose.—To teach the pupil that in order to water a plant properly he needs to watch it closely and use his judgment; and that neglecting to give plants water one day cannot be compensated for by giving it twice as much the next day.

The study of what constitutes plant comfort is a most interesting one. For illustration, let me mention the importance of one item, that of water, and the large quantities required by a plant during its growth. An acre of corn has sweat out through its leaves during its growth to maturity, an amount of water that would cover that acre from seven to nine inches deep, all of which was taken up by the roots from the soil. The amount is not all the water the soil has had to supply. We have no adequate conception of the amount that passes off into the air from the soil by evaporation. If we were to add together the two means of water dispersed, you might perhaps think the farmer must needs have a fire department to sustain the supply. You must remember that where the great consumption of water by plants exceeds all others is when they grow in window boxes, vases and pots. The amount that evaporates from such recepacles with all sides exposed to the hot air is far beyond that from the soil in its natural position. Rain, as it usually falls, is inadequate to supply the demands of the plants in exposed conditions and the excess must be made up artificially.

There is no question that is asked of us more frequently than "How often must I water my plants?" Plant comfort cannot be arranged by schedule. You do not become thirsty winter and summer with the same frequency. A recipe may be the best means for teaching how to

make a pumpkin pie where conditions may be made nearly uniform but such can never be expected in plant growth out of doors. Again I must impress you with the fact that plant comfort is not a matter of recipe. Such is not true of our own comfort, neither of that of plants. It is the conception of some people that an agricultural education consists in learning a lot of fixed formulas. This is a mistaken idea.

LESSON CLXX.

WHEN TO PLANT SEEDS IN WINDOW GARDENS.

Purpose.—To teach the pupils the necessity of regulating the temperature and giving attention to the condition of the atmosphere in the room where plants are to be grown.

In giving suggestions to an apprentice for the first lessons in plant growth it is best to remember that to the smaller children only a few things should be given and these in small doses. This method will sustain their interest and keep the appetite keen for more. When a farm lad, I was sent to the field to hoe corn. Often the field was long and narrow. The rows ran at right angles to each other. In one direction they were long and in the other short. The field contained the same number of hills whether the corn was hoed by following the long rows or the short ones. Invariably I took the short rows. That was the boy of it. Boys are the same to-day as they were fifty years ago and as I expect them to be a thousand years to come. First, awaken an interest in the subject to be taught and next give instruction by the short row method and your work will be like floating down stream rather than rowing against the current. In the selection of seeds for the first exercises, take those of quick germination and early maturity.

I shall give directions for two types of gardening, one in the house and another out of doors. The first is valuable in getting a familiarity with plants and may be thought of in the light of exercises; and the second as something like a practical harvest. Lessons in germination of seeds like peas, beans, corn, squash and the like may go on at any time of the school year. Sowing of seeds in the schoolroom for serious growth should be undertaken in March or early April. Avoid the months of December, January, and early February. The reasons for this are two: First, too little sunshine, and second, too much baked air in the schoolroom. During the months mentioned the number of hours of actual sunshine are surprisingly small. The days are short and from the point of view of the plant what light we get is of a weak, inefficient character. This is due to the obliqueness with which the sun's rays strike the earth in the latitude of New York State during that period. (See Supplement.) These months are also the coldest months, and to keep a

comfortable temperature in the schoolroom a greater amount of fuel is burned. This heat is made available by first baking air and then pushing it into the schoolroom. Baked air gives plants a most uncomfortable feeling. The combination of puny light and high temperature is not good. Plants that are thrifty at a summer temperature of 75° to 90° under the strong glaring sun should in winter when the light is feeble be kept at a day temperature of 60° and that of night at 45°. The question of starch factories and the power that runs them as spoken of in the December issue will explain the reasonableness of this statement. I recall how once a principal of a school in a comparatively new building showed me the perfect sanitary conditions of different rooms. In one room was a collection of thrifty plants giving every evidence of plant comfort. Those plants told me the conditions of heat and ventilation more eloquently than the best sanitary engineer could have done. Beginning with March the average is not so cold and, therefore, the air that is supplied the school rooms is not so much baked and has a greater per cent. of moisture. Incidentally, let me say there are some salamanders and camels in plant life that can endure the fierce heat and simooms in schools and living rooms and not be dead by spring. As many homes are heated, the moist air and lower temperature of the kitchen afford plants the most comfortable quarters in the house.

LESSON CLXXI.

BOXES AND POTS FOR PLANTING.

Purpose.—To make the pupil understand that common and cheap receptacles are just as good for holding the soil in which seeds are planted as are the more expensive boxes and pots.

The receptacles in which to sow the seed for indoors are three, viz.: egg shells, two and one-half inch pots, and quart berry baskets. There are some conditions where the egg shells are about all that the children will be able to provide. Empty egg shells are very fragile but when filled with soil will endure considerable handling. After filling with earth, a small hole must be made in the bottom for drainage; they should be set in a pan or box of sand, so that they will be supported in an upright position. The two and one-half inch pots are not expensive, —not more than a cent apiece—and will be found convenient. The quart berry basket in some communities is most available. If the room in the window seat is limited the owner of the berry box may be thought of as a land baron, because of the greater space occupied as compared with the others, yet if more than one variety of seed is sown it is none too large. It should be lined with paper before being filled with earth and some holes should be made in the paper lining for drainage.

LESSON CLXXII.

THE SOIL FOR WINDOW BOXES AND ITS PREPARATION.

Purpose.—To teach the pupil what kind of soil is best for plant growth and how it should be prepared before putting in the pots or boxes.

The question where pupils can get a supply of soil to fill the egg shells, two and one-half inch pots or the quart berry baskets is one for the teacher to decide. If she is within easy reach of a florist a supply from him will be ideal and the expense for the amount required will not be more than five or ten cents. His potting earth is mostly composed of rotted sods which composted with some well rotted manure means abundance of humus. (For importance of humus see Lesson CXXXIII.) If the soil on which the sods grew was of a clayey tendency, the florist will have mixed some sand with the compost to prevent the potting earth from becoming too hard from frequent watering. (See October issue, page 36.)

If you have had previous experience and you wish to teach all the details possible regardless of convenience, you should go to the woods and gather leaf mould to mix with any good garden soil; or if leaf mould is not obtainable, mix sand with the garden soil to give friability. (See October issue, page 36.)

The florist screens his potting soil through a one-half inch mesh. When such screened soil is put into the egg shells, pots or quart berry baskets, it will be too lose—the grains of soil are not snuggled closely together to give compactness. Therefore, jar the soil to settle it and fill again, leaving a top margin of one-half inch as a rim to hold the water—when plants are taking a bath. The owner's name may be written on the receptacle and it may be called his farm. These farms may be used as a means of discipline by occasionally permitting the owner, if of good conduct, to have his farm on his desk for examination. Put it in the light of a privilege. To gaze at a few stalks of peppergrass that are his property means much to him and he will see more things about them than many people ever dreamed they possessed.

LESSON CLXXIII.

PEPPERGRASS AS A WINDOW GARDEN CROP

Purpose.—To have the pupils sow the kind of seed that can produce plants quickly.

The seed that best suits the circumstances of young children is peppergrass. It is seldom sold at retail stores in small packages but may be found in the catalogue of all seedsmen under the name of

cress. While peppergrass and water-cress belong to the same family, they have widely different tastes as to plant comfort. The water-cress delights in water as much as a duck, while peppergrass has a preference for dry ground as much as a hen. Peppergrass is one of the cheapest to be found among the garden seeds—five cents a paper or ten to fifteen cents per quarter pound. When you are well acquainted with the merits of this plant, both for demonstration and for the open ground garden, to be used as a salad, a quarter pound should be your minimum order. The plants will be peeping through the soil in about a week after sowing, which is as short a time as can be expected of any variety of seed. I suggest that the seed be sown too thick rather than too thin. In the former instance, the plants may be thinned when about an inch high and eaten by the owner. It is true the harvest will be but a nibble, yet it is a product of his own farm and will be as much as a feast will be later in life.

LESSON CLXXIV.

SOWING THE SEED AND CARING FOR IT DURING GERMINATION.

Purpose.—To teach the pupil how to sow the seeds and how much covering to give them.

The area of the "farms" is so small that the seed should be sowed broadcast, and the young farmer should learn to accomplish this by rolling it between his thumb and index finger This is a bit of handicraft that can be acquired only by practice.

FIG. 2.—*Sowing the seed.*

The pupil may be given frequent exercises by sowing the seed over a paper spread on a table or desk. When the seed has been distributed it can be gathered up, and the process repeated as many times as the teacher thinks best. In sowing in the pots described above, the seeds may lay about half an inch apart. If they fall irregularly an adjustment to regular distances may be done by means of a tooth pick.

The sowing of seed is usually a serious matter with a child—as much so as writing the first letter. The amount of covering for seeds should be about four times the size of the seed This is a rule with many exceptions. As an exceptional instance, peas should be planted in the open ground four inches deep, which is much deeper than the above rule. This is done that the roots of the peas may be down in the cool and moist soil. For a variety of plants, some

lettuce and radish seed may be sown also, more for a wider acquaintance with plants, than for the harvest, but peppergrass should never be omitted. Let it be the main crop. When all the farms have been sown they may be put in shallow boxes that the gardeners call "flats." The bottom of each flat should be carpeted with an inch of sand. This sand helps to hold the moisture. The bottoms of the eggshells may be dented in the sand so as to keep the farms right side up. Next comes the process of watering the farms. This watering must be a type of all waterings that are to follow. The flats should be placed where the water that slops over will do no harm. Drench the soil on the farms until the water drips out of the drainage holes in the bottom, then stop. Allow fifteen minutes for farms and flats to drain and then place in a warm—not hot—place for germination, which will occur in about a week. During the period of germination light is not necessary but as soon as the young plants show their heads through the earth the "flats" should be placed in the window seat for light. If during the period of germination the soil should become dry the embryos will die, no plants will appear and your probable conclusion will be that the seedsman has sold you poor seeds, when the fault was yours and not his. Every year tons of seeds fail to grow from this cause and the seedsman is censured.

LESSON CLXXV.

HOW TO MAKE THE YOUNG PLANTS COMFORTABLE.

Purpose.—To lead the pupil to consider the several ways of making the growing plant comfortable; and that plant comfort depends upon the soil, its condition, water, heat, light and tillage.

The south window gives the best light and the north the poorest. The east and west stand between the two as to merit. As your location will be one of those circumstances over which you have no control, make use of what you have and let it go at that. If the light is poor and the air too much baked the peppergrass plants will be spindling or "leggy" as the gardeners say. Let me again say that you should accept the conditions as you find them, and do not fail to sow peppergrass even though the conditions are not ideal. Even if uninstructed in observation, the child will see a lot about plants of his farm because they are his very own. No matter if the child does not carry the peppergrass plants through to maturity—in fact you had better plan that he should not if he could. I prefer that he use the same pots for two sowings of four weeks each than to carry one sowing through eight weeks. The object is for the drill, an exercise rather than a product. The inspiration of ownership, the credit of having a farm of

thrifty plants with an occasional taste of the crop will be an attraction that will make the exercise a delight. Help the child to learn to find pleasure in seeing plants grow.

It must be remembered that plants growing in pots, vases or window boxes are under unnatural conditions and require an unusual amount of attention to keep them comfortable. Arouse yourself to the importance of water for plants under such abnormal conditions It is rare to see plants in a pot on a window sill, even when under the care of a capable gardener that do not at times suffer from thirst. I once knew a girl who worked in the kitchen and who had about the best window box I ever saw. It sat on the tin roof of a veranda on the south side of the house where all summer the sun's rays beat down like innumerable trip hammers. She was of the kind " for whom plants do well." All of which means that she knew how to make plants comfortable. Her success was due to two principal things:

Friable soil.

Plenty of water.

During the hottest days she gave the plants water three times each day. When she watered, she drenched the soil so there was surplus that drained out through the holes in the bottom of the window box. When the shorter days and colder nights of September came, she gave water as infrequent as every other day.

Let the children do the watering under your direction. Put the halo of privilege about the responsible undertaking. You are to judge of the time necessary to water. The surface of the soil will be dry, and will crumble, but we expect that. When you water, drench the soil. When school closes on Friday, water and place the flats holding the farms out of the direct rays of light, otherwise you may find the plants dying of thirst on Monday morning.

Many school rooms are not heated during Saturday and Sunday and often a cold snap happens during the last days of March. When such an event is anticipated, shield the plants with a paper overcoat. The character of school buildings varies greatly, ranging from the district school with its box stove with wood as fuel, to forced draft in the city schools. The rural teacher may be her own janitor and the town school may have a most reliable and courteous one who will volunteer to look after the welfare of plants when school is not in session. Between such extremes I can give no hard and fast suggestions. Do not be dismayed because of accidents. Do not begin with any definite or fixed ends to accomplish. In that case you need have no sense of failure. In fact, count no accident a failure, but rather congratulate yourself on having had an opportunity for a lesson.

LESSON CLXXVI.

THE COLD-LOVING AND WARM-LOVING PLANTS.

Purpose.—To teach the pupils to discriminate between those plants which can endure the cold weather of early spring or late fall, and those which thrive best when planted in warm weather.

To the children I make two divisions, or classifications of plants, viz: the polar bear class and the monkey class. At the time when the vertical rays of the sun are giving the equatorial boy a hot time, we in New York may sow the seeds of the polar bear class; at least as soon after that date as the frost is out of the ground, and the soil is dry enough to work. That time may not come until the middle of April, and even later in the northern counties of the state of New York. See *Nature-Study Leaflet,* 1906, No. 1, p. 35.

Another reason for sowing the seeds of the polar bear class as early as the condition of the ground permits, is that such plants may do their season's work before they suffer too much from the severe heat of midsummer. Sweet peas and green peas, lettuce, radishes, and the like, each belong to the cold-loving class, and if they are sown as late as the last of May, their season will be unsatisfactorily brief. We often read in seed catalogues and garden books "sow at intervals for a succession." Writers when speaking of the cold-loving plants have no excuse for giving such misleading directions. During the straw hat and shirt sleeve days of late July and the month of August, peas are liable to mildew, lettuce and peppergrass will go to seed, radishes will also prematurely go to seed, be hot and tough to the taste, and probably become wormy. If a succession is desired, the sowing should be deferred until the arrival of the cooler and shortening days of late August or early September.

LESSON CLXXVII.

THE SALAD GARDEN.

Purpose.—To teach the pupils how and when to plant some of the seeds which can endure the cold, and which should, therefore, be put in the ground early.

For this early garden,—the first step of the apprentice—I shall recommend only the cold-loving class of plants, placing my preference in the order that I mention them; viz., peppergrass, and onion sets. Devote at least half of each child's plot to these two. Next in preference come lettuce and radish. The latter may have leaves the size of a cat's ear by Decoration Day, which the young gardeners may observe

by having a salad sandwich festival—of the details of which I will speak later.

Directions for planting the seeds and sets are in every reliable seed catalogue and, therefore, need not be repeated here.

The chief mission in having plants in small pots in the school room is that the children may become acquainted with at least one kind of plant, also to know the pride of creation and of ownership. Those two objects are the controlling ones, and the harvest whatever it may be in the stalks of peppergrass, is incidental.

I now wish to speak of out-door planting. This plan gives an experience and also a harvest worthy of consideration.

Location of Garden.

The type of apprentice garden that I have in mind for you to undertake will not have a life of more than six to eight weeks. This I consider to be as long a period as we can reasonably expect to maintain the interest of a child who is an apprentice in gardening. Before the close of school in June, all the crops will be harvested, and the garden ready to be abandoned. By this plan the teacher need not provide for any care during the summer vacation, which is always a serious problem in school ground gardens. Also the enterprise should be abandoned before interest declines, and it becomes a bore to the child. I have spoken in previous pages of giving instruction in small doses. As the purpose in apprentice gardening is for instruction to be given by the teacher, the planting must be made on the school grounds, or on an adjacent lot. Most children outside of congested parts of cities have opportunities for plants at their homes. To all such, urge that they have duplicate gardens at their homes under the parents' eye and encouragement. These home gardens often educate the parents as well as the child.

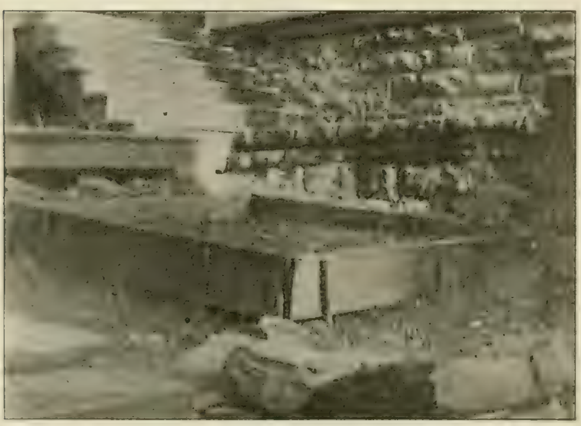


FIG. 3.—*This garden is about as large as a good sized handkerchief.*

Size of Garden.

The question is not so much how large, but how small the garden shall be. We must not forget that

these first steps, like all children's steps, must be made short and simple. Let them do their work by the short row process.

I would suggest that an area as large as that of a handkerchief, albeit a large handkerchief, will be sufficient for the average child. Certainly an area two feet square should be the limit for the most efficient apprentice pupil in the lower grades. It will seem much larger to the child at the end of eight weeks than in the beginning, when he has the enthusiasm of a young convert.

Preparing the Soil.

Many school grounds are a combination of lawn and juvenile athletic field, with the general appearance of a Sahara. I have no comments to make on such an appearance so long as girls and boys find plenty of exercise. Even in such instances, a border on the outer edge of the grounds may be found that will not be disturbed by tramping feet. If the garden is made next the walls of a building, I would ask you to turn back and read what is said on page 36. The form of a plot should be long and narrow—about two feet in width, so the young farmer may reach to the center from either side. An ideal garden soil should be very fertile. By that I mean that it should have a fertility that is immediately available to the plant. In other words, a sumptuous, quick lunch soil. Such condition may be partly determined by tests for the amount of humus, as given in Lesson CXXXIII. If found deficient in that important ingredient, spade in rotted sods and leaves. For a veritable hurry-up lunch—a form of plant food that will immediately be available—nothing contains a greater combination of virtues than well-rotted stable fertilizer. If this is spread over the garden to the depths of four inches, and thoroughly mixed with the soil by spading, and the soil worked to a friable condition, you have a soil that has "ginger" in it.

Spading.

After determining the size of the united gardens, the ground must be spaded and that very thoroughly. All the stones down to the size of an overcoat button, should be picked out, also grass roots and in fact all roots, otherwise they will plague you by soon developing into plants. No matter how much they are desired before, if they appear in your garden, where they are not wanted, they become weeds—and weeds are plants out of place. There is no probability that the preparation of the soil will be overdone in thoroughness.

When a boy, I was the only girl mother had, and I was often required to chop the hash in a big well-scoured wooden bowl. Under

some circumstances the assignment was acceptable, but when another boy, sitting on the wood pile outside the kitchen door, was waiting for me to go fishing with him, chopping hash was a bore. If the chance offered, the bowl was put into the pantry with the chopping about half done, even though I knew I should be called back to do the task over again. Do not let the children slight the spading as I did the chopping of the hash. Pass the work around, and put it in the light of a privilege, as Tom Sawyer did that of whitewashing the fence.

FIG. 4.—*A spading fork at the proper angle to press into the soil.*

Fig. 4 shows how the spade should be placed in the ground vertically, by pressing down and wiggling sidewise and perhaps forward and backward, that the tines may dodge any obstacle they chance to strike. The spade should be pressed down full length, then pull the handle toward you, using it as a lever, the full spadeful may be lifted from the ground, and should be inverted like a griddle-cake when dropped. That spading fork full will nearly always be lumpy. These lumps must be made fine by spanking them with the back of the spade. (See Fig. 1.)

If any debris remains in the spaded soil, it should be spaded and spanked some more. Then the garden rake must be pushed back and forth as a girl would pass the comb through the hair. This is one form of tillage, and tillage means fertility—a fact that I hope I may have the opportunity to explain when your pupils are promoted to journeymen gardeners.

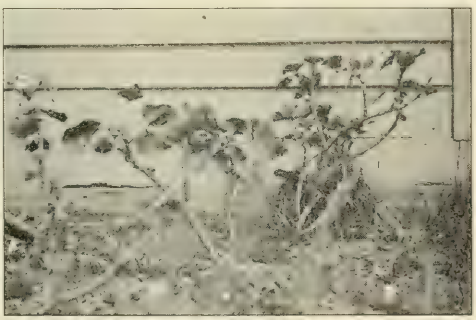
If the soil of your gardens has a tendency to be clayey, do not disturb it when wet. When spaded in such condition, even though thoroughly spanked, the soil will dry out lumpy. See page 36, October issue, where experiments are recommended in making marbles from wet clay, and also from partially dry clay. A clay soil is much improved in friability by mixing with it organic matter or sand.

Season for Planting.

It is with serious purpose that I would correlate physical geography with the season for planting seeds. To the inexperienced all plants may seem alike so far as adaptability of season is concerned. To

think so will lead to many failures in gardening. More than a majority of plants that we have in cultivation are foreigners. Although they have been much improved in productiveness or brilliancy of bloom, in the last half century of citizenship, they still retain much of the old country temperament. The pansy is a familiar illustration. Half a century ago, when I trudged back and forth to the red schoolhouse, dinner pail in hand, I passed a bed of what to me were the most beautiful flowers in the world. Twice each day—going and returning—I would gaze through the fence, and converse with those faces. To some of them I gave names. They were "Johnny-jump-ups" then. Now with all the skill of the plant breeders, they are pansies. With all the marvelous improvement in splendor of colors, they have not changed their temperament in being cold-loving plants. Not many years ago, I received a letter from one of my school girl nieces, which read like the following:

"Dear Uncle John; My pansies are sick. I am afraid they are going to die. I do not think my pansies want to die any more than I do. What shall I do for my pansies?"



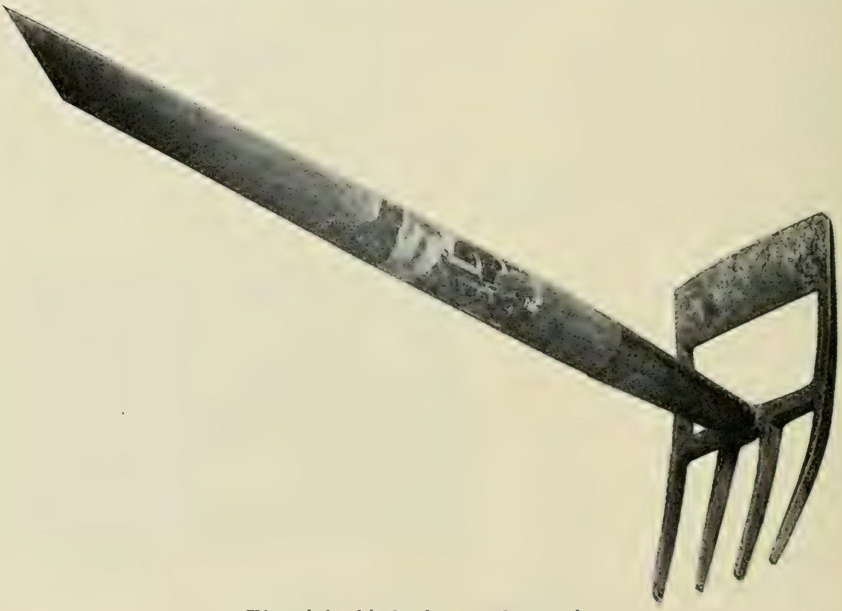
Some geraniums that have not been made comfortable.

Believing in the impulse of motherhood in plants, I knew my little niece was right; her pansies did not want to die. Also knowing that they are cold-loving plants, I could well understand why they were sick under the heat of droughty August. As a plant doctor I explained the situa- to my young friend, and for treatment directed that she pick all the seed pods, so the plant would be relieved from the labor of producing starch lunches for the seed; that she give the pansies partial shade by putting a frame of slats over them; also give the plants plenty of water. I said she must keep them in this sanitarium until the shortened days and cooler nights of late September came, and then her patients would be fully recovered. This would be about the date when Equator Shem would for the second time in the year have no shadow, for the vertical rays would be moving south. Pansies attain their greatest glory in the cool and moist climate of England and Holland. I am told that they also are very comfortable in the state of Oregon. They are among the most popular of our early spring flowers, and seem comfortable and cheerful during some of the sour and snow squall days of April,

under conditions that would cause a hill of beans to turn yellow and shiver with an overcoat on, so to speak. It is because of this difference of plants that I have laid stress on the position of the sun's rays as a guide for planting.

Tools.

About the poorest service for cultivating are the tin and sheet iron things personifying trowels, spades and rakes, sold at the hardware and five and ten cent stores. They are but toys, and fit only for use in kindergarten sand piles. Yet for apprentices it may be just as well to



The right kind of a garden tool.

buy them. A good tool, children of younger years will lose or fail to keep clean, and the tools lose their efficiency by rusting. The adult who spades or otherwise prepares the handkerchief gardens, must have a spading fork and garden rake to give the soil a thorough preparation. When the children are advanced from apprentice gardeners to the grade of journeymen gardeners, they will require more effective tools than the sheet iron and pot metal things spoken of above.

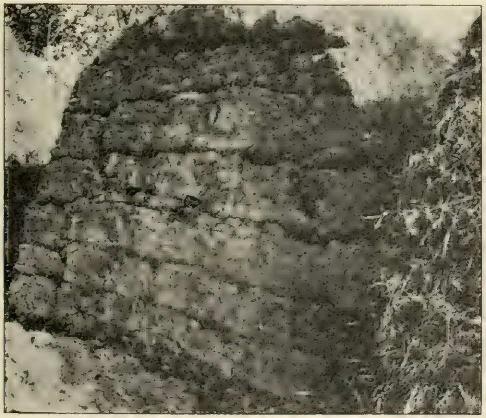
Sowing of Seed.

I do not mean sowing a long and promiscuous list of seeds, but sowing the apprentice list of the polar bear class that I mentioned on a previous page. The indoor experience of sowing peppergrass, radishes

and lettuce, should be a guide as to the amount of covering to give the seeds, and the general care in watering. This last necessity will seldom occur during the inclement weather of April.

The rows in the handkerchief garden should be made about five inches apart. A very good method to get straight rows is to have the pupil stand on a board having a straight edge while he scratches a shallow groove in the soil. Onions have several forms for reproducing. That of sowing black seed is used by the commercial grower who has areas of many acres, and the harvest is not until fall. For early sorts for spring use onion "sets" should be planted. The sets may always be had at the grocer. The sets must be nestled into the soil tc a depth so the top part is just beneath the surface.

Not many weeds will appear in April and early May, but whenever one appears, have the young farmers pull it up. A little teaching will be necessary at first, that they may identify weed plants from the farm crop plants. Teach them that weeds are robbers in that they take plant food and moisture from the crop that the plants want for best growth for that sandwich festival. Another point to give them is that the best time to fight robbers is when the robbers are babies.



Composted sod makes humus—rich potting soil.

A LETTER TO THE TEACHER WHO IS FOR THE FIRST TIME UNDERTAKING SCHOOL GARDENS.

My dear Teacher:

You can accomplish almost anything with children if you will enthuse them. Enthusiasm is like steam in the cylinder of an engine. With the teacher as a balance wheel something may surely be made to happen. A boy or girl likes appreciation, and should have it when there is an occasion for giving it. What gives them great animation is the thought that they are doing something worth while.

It is compliments for the small things that count, rather than those of the sweeping fulsome sort for the large. The first achievements, even though they seem small to us, are very important to them.

That the children be finally taught thoroughness is needful, yet it can be carried too far in taking first steps—so far as to disgust and discourage. Let them make the first circuit of the race track at their own gait, and then let improvement be made by making circuits under coaching rather than by nagging their first attempts.

In a way, merit is a relative quality. At the many flower shows that I have attended, I have seen children bring for exhibition a handful of flowers as smudgy as a bedraggled vagrant back yard cat. The handful of flowers brought would be a pathetic lot to those who have a florist's standard, yet to the one who raised them, they were the apple of his eye. No doubt any of us would be proud of what we had accomplished, if we had raised them under the unfavorable conditions that the boy or girl found. It would be manifestly unfair and discouraging to tell the child of exultant spirits that his standard was too low, and there was no place on the benches for his marigolds and zinnias. I know the impulse is to make the greater ado over the paragon who does not need the ado, and forget the delinquent, who is such mostly because he has not had a chance.

One of the dangers of children's gardens when planted in so public a place as the school grounds is that of boy vandals—I have never known girl vandals. It is of no use to scold or threaten or preach to the offenders. Your annoyance is the greatest compensation they find for their "cussedness." Your best protection is tactfulness, and often that is not sufficient. I know of some instances where the children—the owners of children's public gardens protect their property by their own vigilance, but that is not always successful. A boy is more inclined to respect the rights of others when he has once known the pride of ownership himself.

The pride of ownership has a power for good citizenship that is not fully appreciated. The good influence of ownership in making a better future citizen of the youngster is usually overlooked when making an inventory of the benefits of children's gardens. The adult or the child who has never felt that pride usually looks upon the destruction of property of others as a joke. However, I regret that in many instances tactfulness and even police powers do not protect school-ground gardens.

I would repeat what I have said previously, that the child should be encouraged to have a duplicate handkerchief garden at his home where such is possible. A home garden is under greater protection. The parents become interested in flowers and vegetables because their children are. The parents' interest is a wonderful incentive to the child. The area of even so small a plot as four square feet is capable of furnishing what to a child would be several delightful collations.

Do not expect that everything planted must reach maximum success. I fancy the shrewdest business man the world has ever known hardly found all his investments profitable. Garden enterprises have about the same history of success and failure.

By Decoration Day your peppergrass, onions, and to some extent your lettuce, will be available for the feast. The peppergrass and lettuce leaves and hard boiled eggs must be chopped, to which some of the onion may be added to give desired flavor, to all of which add mayonnaise dressing. When all this is made the filler between thin slices of bread, you have a sandwich worth a king's ransom.

The festival may be appointed for a Friday afternoon. If your school has a principal, and he has been skeptical as to the utility of the work of your apprentice

class, send him some of your sandwiches. If he is a man with good digestion his conversion will be immediate.

The duplicate gardens at the children's homes may be made the source of delightful Sunday eve lunches after a sumptuous two o'clock dinner.

In the home garden, when the cool-loving vegetables show the deteriorating influence of the heat, a crop of string beans may supplement them. Beans belong to the warm weather loving class.

I fancy one of the most cheerful things that come into the life of an exile is to have something to look forward to. Give the apprentice gardener the prospect of a coming harvest to anticipate. Put it in the form of a festival to be made up from the products of this garden. Let him build air castles over its grandeur. Let the picture be something above the commonplace reception with scanty refreshments, but rather a party supper, where all the guests go away well filled. Let the apprentice not only furnish the materials for the menu, but learn the responsibilities of host also.

The pleasure of making an invitation list, and writing out the invitations may be made the subject for "busy work" for a fortnight, preceding the event. If begun early enough, the list will receive many revisions, particularly if each gardener is restricted to a certain number of invitations.

There is a bit of alloy in this scheme which is this: In most of schools the children come from homes of wide difference in social standing. There will be boys and girls from the homes of the plain people—in fact, of very plain people. There will be hesitation and embarrassment on the part of parents from such homes about accepting. The reasons may seem far-fetched to you, but it is a reasonable reason to the mother with meager wardrobe and hands giving evidence of hard work.

Let me suggest that such absentees be sent a neatly prepared package of the good things of the feast, accompanied by kind messages endorsed by the teacher and children host. Kind words are immortal—they never, never die—and are the best of food for hungry souls. Try it and watch for the coming of a comfortable feeling about your own heart.

If you are a teacher of the Heaven-born kind—and I know you are if you take up children's gardens—I am certain I may depend on you to make yourself eligible to receive that blessing.

In selecting the four vegetables—peppergrass, onion sets, lettuce and radish, I have chosen those of the earliest cultivation to be found in the seedman's catalogues, and at the same time give a harvest before school closes in June.

My advice is to abandon the school ground garden during the summer vacation, but encourage the child to maintain the duplicate garden at home.

Among flowers to give earliest blossoms I recommended sweet alyssum and dwarf nasturtium. I say dwarf for the reason that brush or strings are not necessary for supports. When supports are available for apprentice gardeners, I would add sweet peas. All of these belong to the cold-loving class, and should be planted not later than Arbor Day. It is not probable that any will blossom before the close of school, and therefore, better be given a place in the duplicate garden at home.

At a future time when I give instruction for the journeyman class, and after that to the Master gardeners, I shall give direction in the management of a class of plants involving larger varieties and greater complexities, and on the part of the gardener greater physical strength and tenacity of purpose than I have given to the apprentice class.

With best wishes, believe me, Yours cordially,

UNCLE JOHN.

JACK-IN-THE-PULPIT.

Crackle! crack! the ice is melting;
From the west the rain falls pelting:
Swish and gurgle, splash and spatter!
"Halloo! good folks, what's the matter?
Seems to me the roof is leaking!"—
Jack from down below is speaking.

You know little Jack? In the spring he is seen on the swampy edge
Of the hemlock-wood, looking out from the shade of the fern-wreathed ledge:
But in winter he cuddles close under a thatch of damp leaves.—
Now the water is trickling fast in through his garret-eaves;
And he opens his eyes, and up he starts, out of his cosy bed.
And he carefully holds, while he climbs aloft, his umbrella over his head.
High time for you to be up, Jack, when every growing thing
Is washing and sunning itself, Jack, and getting ready for spring!

CALLING THE VIOLET.

Dear little Violet, don't be afraid!
Lift your blue eyes from the rock's mossy shade!
All the birds call for you out of the sky:
May is here, waiting, and here, too, am I.

Why do you shiver so, Violet sweet?
Soft is the meadow-grass under my feet.
Wrapped in your hood of green, Violet, why
Peep from your earth-door so silent and shy?

ONE BUTTERFLY.

A purple stretch of mountains,
  And, them and me between,
A bed of sweet, red clover,
  Billows of meadowy green.
Across the wind-swept pastures
  One snow-white butterfly
Sails toward the grand horizon,
  Sole voyager of the sky.

The delicate cloud-shadows
  Win from the mountain sides
Glimpses of shy, strange color,
  That common sunshine hides.
Who reads that revelation?
  We only, thou and I,
In all this noon-lit silence,
  My white-winged butterfly!

—LUCY LARCOM.

The leaflets of the Home Nature-Study Course for next year will continue upon the lines suggested in the syllabus of Nature-Study and Agriculture issued by the New York State Education Department.

Teachers desiring these leaflets for the coming year will please send address and request to the Editor next September.

IN NATURE-STUDY TELLING IS NOT TEACHING.

"Persons hesitate, fearing that they will make a mistake. A teacher asked me the other day where he should begin with nature work. He had been considering the matter for two or three years, he said, but did not know how to undertake it. I replied, Begin! Head end, tail end, in the middle—but Begin! There are two essential epochs in any enterprise—to begin, and to get done."

"There can be no objection to the poetic interpretation of nature. It is essential only that the observation be correct and the inference reasonable, and that we allow it only at proper times. In teaching science we may confine ourselves to scientific formulas, but in teaching nature we may admit the spirit as well as the letter."

"The child should be set at those things that are within its own sphere and within the range of its powers. Much so-called nature-study teaching is merely telling the child what some man has found out."

"Thoroughness consists only in seeing something accurately and understanding what it means. We can never know all that there is to be learned about any subject."

"One is not superficial merely because he does not delve deep into subject-matter. He should try to be accurate as far as he goes."

"I would not have every teacher teach nature-study any more than I would have every one teach grammar. Every pupil should have nature-study under one name or another, but he should receive his inspiration from the teacher who himself is so full of the subject that he teaches with spirit and with cheerfulness."

L. H. BAILEY in *The Nature Study Idea.*

Junior Naturalist Monthly

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ALICE G. McCLOSKEY, Editor.

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I love to wander through the woodlands hoary
  In the soft light of an autumnal day,
When summer gathers up her robes of glory,
  And like a dream of beauty glides away.
—SARAH HELEN WHITMAN.

TO JUNIOR NATURALISTS.

This new school year we are glad to welcome our boys and girls who have been with us so long and also to welcome the new members of the Junior Naturalist Club. We shall try to make this year full of happy times and rich in useful knowledge of the out-of-doors. There are treasures of all sorts hidden along the wayside; we shall teach you to find them. We want you to be a band of young farmers with the whole outdoor world for your farm. Let us consider some of the things we would learn on this great farm—things that will give you pleasure in the learning, and be helpful to you if you should ever be a farmer.

Black-eyed Susan.

1. There are the birds, all of them living their own lives in ways that are best for them. Every one of the birds is worth knowing for itself and for the part that it has in the great outdoor world. We shall also find that these birds have relation directly to the farmer—some aid him in his occupation and some hinder. We do not need to destroy those that hinder him, but we should take extra pains to protect those that aid him.

2. Domestic fowls. Every boy and girl is interested in domestic fowls. Let us see how much we can learn about them this year—ducks and geese and chickens. How many kinds there are; how they differ, one from another; their habits; why some farmers are successful in raising fowls while others are not; in what ways they are useful and harmful to the farmer.

3. Little wild animals of field and wood.
4. Domestic animals.
5. Crops.
6. Weeds.
7. Wild-Flowers.
8. Trees.
9. Insects. Useful and harmful insects.

What a great many things you can learn! If you should attend school five or six years, and all that time you should spend a small part of each day studying the great farm that belongs to us all, you would know a great deal that would be useful and interesting later in life.

THE NATURE-STUDY CORNER.

Ask your teacher if you may have one corner of the schoolroom for your nature-study materials. Tell her you will keep everything neat and attractive in this corner. There should be a table so that all your specimens can be placed on it until your teacher has time to talk with you about them. You will bring in specimens of trees, plants, insects and other things that you find, and if you put them on the table in neat order, the teacher will find it more convenient to study them with you. If you have plant specimens put the stems in water. If they are laid down carelessly they will soon wither.

Sometimes your teacher cannot tell you anything about your specimen. No one knows all things out-of-doors. It will be a good idea, therefore, to have a shelf in the corner for Nature-Study books so that you may consult them. Perhaps your Trustees or Board of Education will provide a few books for this purpose. Write to your Superintendent of Schools or your School Commissioner about this. You will need at least five books and I would recommend the following:

"Bird Life," Chapman; "Bird Neighbors," Neltje Blanchan; "Insect Life," Comstock; "Field Book of American Wild Flowers," Schuyler-Matthews, or "How to Know the Wild Flowers," Dana; "Our Native Trees," Harriet L. Keeler.

THE COMMON DAISY AND BLACK-EYED SUSAN.

The common white daisy is known to every child. You like to see it, you like to gather it, you like to make daisy chains. As naturalists you ought really to *know* the daisy and find out whether it is a wise thing to let it grow on your farm.

Take up a daisy plant, root and all, and make a drawing of the root if you can. Tell Uncle John whether you found it difficult to get

the whole root. Look closely at the flower head. Each daisy is made of a great many tiny flowers. Study the daisy when it has gone to seed. Do you think one plant would produce a great many plants another year? Why do you think daisies annoy the farmers?

Plants as you know are related. There are families of plants as well as families of persons. They do not always look like their relations, but we often find members of our own family that do not look alike. While you are studying the common daisy, you may come across one of its relations, the black-eyed Susan. Each of the blossom heads of this plant, too, is made up of a great many flowers. Some day you will learn many things about these flowers, but now it will be enough for you to know that they are there and to look at them closely. Where do you find the black-eyed Susan growing? Which is the more common the white daisy or the black-eyed Susan? Write to Uncle John and tell him five things that you learn from the study of the stem, leaves, and flower heads of this sturdy wayside plant.

FIG. 2.—*Golden-rod. How does some of the golden-rod that you find differ from this?*

Have you ever made "little grandmothers" of the white daisies? Try it some day. With a sharp pair of scissors clip all the petals but two, a little more than half their length. You will see a round golden face surrounded by a frilled cap-border, the two untrimmed petals being the lappets to the cap. If the daisy is a fresh blossom it is easy to draw with a soft lead pencil a few marks for eyes, nose and lips and the little nodding grandmother is indeed amusing.

THE RED SQUIRREL.

A long time ago, one fall day, I went for a walk with a class of children. The young persons had promised to be very good in school all the afternoon if I would take them into the woods, so at four o'clock we started. We took a small basket in which we could bring home all the different kind of nuts we could find. We wanted to learn something about them, so we planned, if possible, to carry back a branch bearing the nuts. What a good time young folks can have with their teacher

on such a trip, and what a long, long time you will remember it all—the golden sunshine, the bright colors of the trees, the rustle of the fallen leaves, the quiet woodland.

But I suppose long after the children who were with me that day forgot the beauty of the October afternoon, they still remembered a little red squirrel that seemed to resent our appearance in the wood. As soon as he saw us coming he commenced to scold, as is his custom. The woods belonged to him, and who were we that we dared enter?

Now it may be that your teacher will take you out some October afternoon and that you, too, will see a red squirrel. If so, I want you to try to find answers to some of the following questions. Those that you cannot answer right away, you may be able to find out before the close of the year.

What is the color of the squirrel on the upper parts? Underneath? What is the color along the sides? Does it carry nuts in its teeth or in its cheeks? Does the red squirrel store food for winter use? If so, where? Do not answer this question until you have watched the red squirrel and found out whether or no it provides a winter store. Does it seem as if the squirrels have certain paths in the tree top which they follow? Perhaps as you sit in the woods, many of you can tell some interesting things that you have learned from the red squirrel's life. Have you ever seen one disturb a bird's nest? Find out during the year all the kinds of food which you know the red squirrel eats.

ASTERS.

The word Aster means "star-like." Can you tell me why these plants were so named?

Some of you may think of asters only as garden flowers; but the kind that you see in the garden is the China aster. I am now speaking of the wild asters, white and blue and pink, that bloom in field and wood and along roadsides all the autumn.

Find as many different asters as you can. Some day the teacher may let you have a language lesson on asters to learn the ways in which they differ one from another, for asters do differ in color, size of blossom head, kind of stem, leaves, and in other ways. It is interesting to learn about them.

1. Note size of blossom. Color.
2. Is the stem slender or stout?
3. Are the leaves heart-shaped or long?
4. What is the length of each stem?
5. How does the aster look when it has gone to seed?

GOLDEN-ROD.

Where do you find golden-rod growing? Perhaps some bright afternoon the teacher will let you have a golden-rod hunt, not to gather great quantities of golden-rod but to see how many kinds you can find. Some persons think that all golden-rod is alike but Junior Naturalists will find different kinds. Take one specimen of each back to the school-room so that you will have plenty of time to learn the ways in which the sprays of blossoms differ. Then write to Uncle John and answer the following questions:

Where did you find the golden-rod growing?

How many kinds did you find?

About how high was each stem?

Where were the blossoms, on the end or on the sides of the stems?

What difference did you find in the leaves? Are they round, broad, toothed?

How do the stems differ in color? Is the stem hairy or smooth?

RABBITS.

Animals are related to each other as well as plants. If you learn about them, you will sometime take great pleasure in finding out the ways in which we know that certain animals are related. As you study rabbits and squirrels, I wish you would try to learn whether they are similar and in what ways.

Many of you have had bunnies for pets, but I am not sure that you can tell very much about them. Can you tell how many teeth Bunny has in his jaws, and how these teeth are placed? Does he use his paws in holding the food as he eats? Are the inner palms of the paws naked like those of a squirrel or mouse, or are they furred? How do you handle a rabbit when you take it from one place to another? How does Mother Bunny move her family? All wild mothers have some way of carrying their helpless young.

A teacher told me of an interesting experience that she had in conducting a drawing lesson for which rabbits were the models. One of the pupils brought them to school, and all morning they cuddled in a basket, making no disturbance. When it was time for the drawing class their little master placed them on a table. They sat very still while the class made their drawings, some pupils at the blackboard and the others drawing on paper. When their master wanted them to sit up, he lifted them by the ears till each one sat up like a little post on hind legs and tail. They remained quiet while the class worked. This teacher wonders whether other rabbits would behave as well in the

schoolroom. Perhaps some of you own rabbits and your teacher will let you bring them to school for a lesson in language or drawing. If so, write to Uncle John and tell him your experience.

FIG. 3.—*It is fun to feed a bunnie.*

THE TERRARIUM.

Every year there should be a cage of some kind for animal life brought into the schoolroom. In Fig. 4 you will see an illustration of one that has proved a great success. Monarch butterflies, cabbage butterflies, several moths, a hop toad, salamanders, a small snake, a mouse, a shrew, and many other animals have lived in it. Ask your teacher to let you have a terrarium. A soap box with wire top will do.

FOR ALL TEACHERS.

Should your Superintendent of Schools or School Commissioner recommend the work sent out by the New York State College of Agriculture at Cornell, I hope you will consider the matter seriously. We are in a position to help the young

FIG. 4.—*A home for animal life. The children are providing a rain storm for the hop toads, salamanders, and the like.*

people in the public schools to a knowledge of the out-of-doors. This cannot be done without your co-operation. Many teachers find Nature-Study helpful in providing live material for language lessons. The letters written by the children to Uncle John give opportunities for instruction in letter writing.

In our Junior Naturalist Monthly, we intend to give suggestions which will help teacher in following the Nature-Study Course outlined in the New York State Syllabus. The subjects for the first year, therefore, will be as follows:

ANIMALS.

Four-footed animals.—Cat, dog, mouse, squirrel, rabbit. Recognition and name, observation of their characteristic movements and actions. Their color, parts, covering, food uses, and care of the young.

Birds.—Chicken, duck, goose, pigeon, English sparrow, canary, robin. Recognition and name. Their colors, parts, covering, food and feeding habits, movements, and songs or calls.

PLANTS.

Seeds.—Bean, pea, corn. Seeds and seedlings—sprouting of seeds observed, the different ways in which seedlings come out of the ground. Parts of plant-roots, stem, leaves. Need of water shown by allowing plant to wilt then supplying water.

Opening of buds.—Horse-chestnut, beech, lilac, hickory. The protection of the buds, watching of the unfolding of leaves.

Flowering plants.—Golden-rod, aster, burdock, geranium, arbutus, willow, alder, dandelion, violet, hepatica, daisy, tulip, pansy, apple, cherry, peach, strawberry. Recognition and name of flowers. The whole plant, parts of plant—roots, stem, leaves. Color, odor.

Fruits.—Apple, pear, peach, plum, chestnut, peanut, acorn. Color, odor, taste, parts, use.

Vegetables.—Potato, onion, carrot, turnip, pumpkin, corn. Color, parts, uses.

"A wee little nut lay deep in its nest
Of satin and brown, the softest and best,
And slept and grew while its cradle rocked,
As it hung in the boughs that interlocked."

Junior Naturalist Monthly

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ALICE G. McCLOSKEY, Editor.

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THANKSGIVING TIME.

At this season of the year, boys and girls have a great deal of interest in poultry yards. I wonder why. They seem to be particularly interested in turkeys. Does any Junior Naturalist know the reason? Well, since you are spending a part of your time among the turkeys, ducks, chickens and the like, you may as well learn something about them.

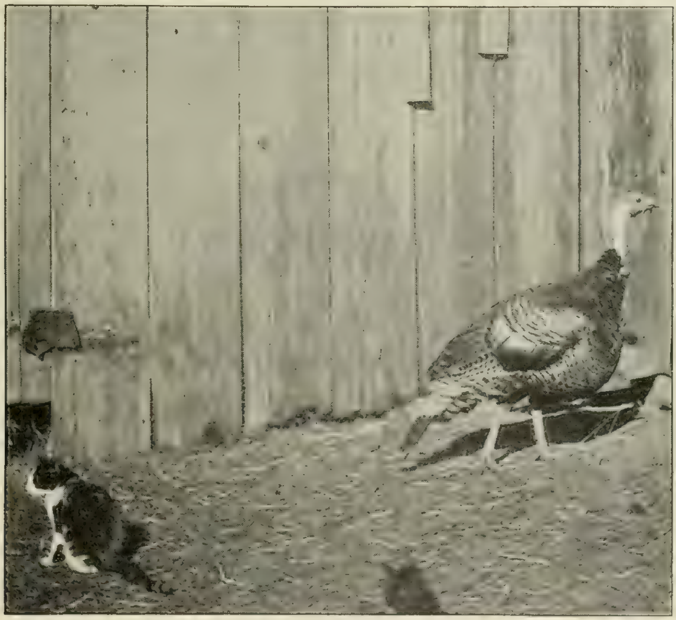

FIG. 1.—*Not very sociable.*

Ask your teacher if she will visit a poultry yard with you some day after school. It may be that for your Nature-Study lessons she will feel she may close school early. This will be more fun than finishing up your work in school. It will be more profitable, too, for boys and girls, particularly in farm districts, should learn to know out-of-door things.

No doubt at Thanksgiving time, you would prefer to study turkeys, so we shall consider them first. Take your leaflet along when you visit

the poultry yard and see how many of the following questions you can answer:

How does the size of the turkey gobbler compare with the largest rooster that you see? Notice the length of its legs. How will you describe the feet? How many colors do you find on one turkey? Describe the face and wattles of the turkey gobbler. Notice the bright, clear, hazel eyes. Notice the scales on the legs of the turkey. Do you find them also on hens' legs? On which side of the leg,—front or back,—are the scales the larger?

Can you tell which is the hen turkey and which the gobbler? On which one do you find a hairy tuft on the breast?

FIG. 2.—*In the poultry yard.*

Did you ever hear of the caruncle on the head of the turkey? Compare this with the comb on the domestic fowl. How does it differ in shape? Do ducks and geese have combs? What is the color of the turkey's face? Does it change color? Do you notice any difference in color when the turkey is angry? What are the turkey's wattles?

Notice the fourth toe. Why is it placed in the opposite direction to the others? I wonder whether it makes it possible for him to grasp the perch, and whether it gives him a wide span for support in running over loose brush.

There are a great many questions above that I am sure boys and girls cannot answer, yet I believe you can find them out if you will spend a little time in the poultry yard.

When mother is preparing the turkey for Thanksgiving dinner, it is always interesting to young persons to take the leg that has been cut

off and by pulling the tendon cause the toes to curl up. If some one will bring to school one of the legs of a turkey or chicken and illustrate this, you may learn why it is that chickens may fall asleep on the perch without falling off. The tendon is stretched as the turkey bends its leg and the toes grasp the perch and hold on. When it straightens its leg to leave the perch the toes are spread out, but not until then.

Write Uncle John a real good letter about turkeys, not those you have read about, but those you have seen.

THE GOOSE.

Ada E. Georgia.

Many persons prefer roast goose to roast turkey for Thanksgiving dinner. I fear that many children know little about this splendid bird except its delicious taste when it comes on the table; but the habits of the goose are very interesting. They are affectionate toward each other and are brave, fierce fighters against anything from which they fear injury. Geese are not silly, although to call anyone a goose is equivalent to saying that he has been very foolish.

Fig. 3.—*An affectionate companion.*

Some of you may have had the good fortune during the autumn to see the "flying wedge" of the wild geese passing, far overhead, and southward bound. Think of the power expended by those wings in carrying the heavy bodies, weighing from twelve to

sixteen pounds, on the long journey through the air at a speed faster than a passenger express train. If you have an opportunity to study domestic geese, I am sure you will find them most interesting. Observe the stiff pinion quills. In the days before gunpowder was known great flocks of geese were raised for the purpose of supplying the armies of bowmen with these quills, the short sides of which were used to feather the arrows; and before steel pens were made the goose-quill pen was the best known. "Penknives were so called because they were carried and kept sharp for the purpose of making goose-quill pens when needed. Notice the different kinds of feathers on different parts of the body. Are all parts of the body feathered? Watch the action of the strong webbed feet and notice how neatly the web feet folds together when the foot is brought forward and upward.

The mother goose is usually a gentle creature but the gander is often a cross old fellow, afraid of nothing, and ready to fight at the least provocation. A blow from his beak or a buffeting from his wings is something to be long remembered.

PUMPKINS AND SQUASHES.

Of course you will all want pumpkin or squash pie for dinner on Thanksgiving Day. What would Thanksgiving Day be without a pumpkin pie? Let us have some pumpkins and squashes in the schoolroom for a lesson this month so that we may learn about them. If we work real hard we will have a much better appetite for all the good things that are coming.

How many of you have ever seen the yellow blossom on the pumpkin vine? If it were rare, I suppose you would think it very beautiful. Sometime next year I wish you would notice this blossom and write to Uncle John describing it.

Of course you know that every plant blossoms in order to produce seeds from which other plants will grow. The pumpkin is no exception, and I dare say many of you have seen little pumpkins beginning to form from the blossom. I do not know anything in plant life more interesting than this. What a splendid protection this plant makes for its seeds! Have a pumpkin in the school some day for a lesson, and note the following:

How many ridges are there on the pumpkin? Notice when you see other pumpkins whether they have the same number. Where do these ridges end? Notice the shape of the strong stem. Some day compare this with the hollow stem of the vine.

Cut the pumpkin open. What do you find inside the shiny yellow shell? How many seeds do you find in the pumpkin? How are the seeds arranged? Where are they attached? Compare the stem of a pumpkin with the stem of a Hubbard squash.

FIG. 4.—*Preparing the pumpkin for the Thanksgiving dinner.*

NATURE-STUDY CORNER.

What have you found for the nature-study corner this month? Doubtless many interesting things; nuts and leaves and different kinds of seeds. I am sure you like to sit by this table and study these things when your other lessons are learned.

One line of work that I want you to prepare for this month is a lesson on oaks. You will find that there are two distinct types of oak trees,—those which have leaves with rounded lobes, and those which have leaves with sharp-pointed lobes. The trees that bear these leaves bear also different types of acorns. I wish you would press some oak leaves and place them on white paper on the nature-study table. This will give you an opportunity to observe them closely.

In studying the oaks, I shall want you to learn the different kinds of acorns. You know, of course, that the acorn is the seed of the oak

tree; if planted and grown under favorable conditions, it will some day become a tree. Plant an acorn and watch the first growth of a great tree.

Acorns sometimes grow on new wood, that is on the latest growth of the tree. In other cases they grow on the wood of last year. See whether you can find these two conditions,—acorns growing on the new wood and acorns growing on old wood. Notice very carefully whether the acorn has a stem or whether it grows close to the branch. Taste the different acorns that you find. Some are bitter while some taste very good. Notice whether the bitter acorns grow on the trees with the leaves that have sharp-pointed lobes, or on one of the trees with round-lobed leaves.

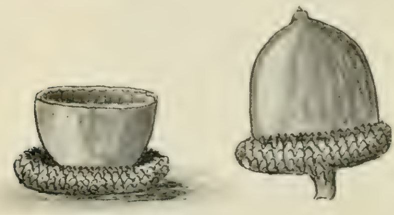

FIG. 5.—*A cup and saucer made from an acorn of the red oak. The acorn at the right is also from a red oak and makes a good top.*

Little housekeepers will probably enjoy the acorns of the red oak, which belongs to one of the sharp-lobed group. You can make small cups and saucers out of these acorns, because the cup of the acorn is deep and the saucer broad and flat. If you will rub each on a stone to remove the point from the acorn and the stem from the saucer, you will find that you have a little cup and saucer for the playhouse. The acorns of the scarlet oak also belong to the sharp-lobed group, and make very good tops because they are so well balanced. I wish the boys would try to spin them and tell us what success they have.

THE BUSY ALDER TREE.

(For the older Junior Naturalists.)

ADA E. GEORGIA.

On my desk lies an alder twig about eight inches long. At its tip, springing from the base of a leaf, on wood which grew this year, is a pendulous cluster of scaly, shining green catkins, each about an inch long. Here are cradled the staminate flowers, of next spring, all ready to " tassel out " before the snow is off the ground and shake out millions of pollen grains—almost the earliest invitation to the bees. At the base of the next leaf is another cluster of tiny cone-like buds, so small that their scales can barely be seen with the naked eye: these enfold the pistillate flowers, and they hold themselves out stiffly, ready to receive the pollen from the nodding catkins. Still below, at the base of the next leaf is another bud, about the size of a grain of wheat, dull grayish brown, and

the least bit sticky to the touch; carefully I open it with a pin, and find within it, not one, but a cluster of leaves, plainly visible to the naked eye. These, too, are waiting for the spring to unfold and grow.

But this is not all that the busy alder has accomplished this summer. Just below, on last season's wood, hangs a cluster of green, cone-like fruits, just opening their scales to the touch of Jack Frost, and scattering the tiny beautiful seeds, which under the glass, look like little red kernels of corn, tipped with a wee pointed horn. Fifty-four scales I count on the one I hold in my hand, and there are six aments in this cluster; if each scale covers one of the fairy nuts, think of the number perfected this summer by the little tree. One would think that alder bushes would possess the earth. Why do they not?

Can you tell whether the alder is particular as to the kind of soil and situation in which it may grow?

Do you think that goldfinches, chickadees, juncos and sparrows might be able to tell why many of the seeds never sprout?

I have said nothing about the leaves—but it will pay you to study the alder tree, and then I hope you will write Uncle John what you have learned from it.

TO THE TEACHER.

In the foregoing lessons it is hoped that the teacher will not try to cover more ground than can be done well. It will be better for the children to have one good Nature-Study lesson a month than to cover all the work superficially. Bear in mind that Nature-Study is the study of the out-of-doors.

The Nature-Study corner represents a small laboratory. The table containing out-of-door specimens will be found useful in giving the children occupation when not employed with other lessons. The simple handling of the specimens will be worth the while. If they learn to consult Nature-Study books in connection with their specimens as suggested in the October leaflet they will be constantly increasing their knowledge of out-of-door things.

The lesson on the alder is too advanced for grades under the fourth but will make a good lesson for fourth, fifth and sixth grades. The children in the first grade should be taught to know the alder which is one of the most interesting trees. They should be shown a specimen and if possible the tree. Then they should notice the cones, also the catkins that have been forming ready for early spring flowering. An active boy of ten years would find an alder in the vicinity if shown the illustration of it. I have experimented with this and have found that children will bring me many specimens of trees and shrubs in this way. The better

plan is to get the specimen first and then to study the illustration, but oftentimes a child will get his ideas from some lesson and find interest in his quest for the object illustrated.

FIG. 6.—*A spray of alder showing the catkins.*

SOMETHING FOR JUNIOR NATURALISTS TO READ.

"Ah! on Thanksgiving day, when from East and from West,
From North and from South come the pilgrim and guest,
When the gray-haired New Englander sees round his board
The old broken links of affection restored,
When the care-wearied man seeks his mother once more,
And the worn matron smiles where the girl smiled before,
What moistens the lip and what brightens the eye?
What calls back the past, like the rich pumpkin pie?"

—From *The Pumpkin* by J. G. WHITTIER.

"With cheerful heart I could be a sojourner in the wilderness. I should be sure to find there the catkins of the alder. When I read of them in the accounts of northern adventurers by Baffin's Bay or Mackenzie's River, I see how even there too I could dwell. They are my little vegetable redeemers. Methinks my virtue will not flag ere they come again. They are worthy to have had a greater than Neptune or Ceres for their donor. Who was the benignant goddess that bestowed them on mankind?" HENRY D. THOREAU.

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ALICE G. McCLOSKEY, Editor.

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WHAT IS THE BURDOCK GOOD FOR?

ADA E. GEORGIA.

"'Good for nothing,' the farmer said,
As he made a sweep at the burdock's head,
But then he thought it was best, no doubt,
To come some day and root it out.
So he lowered his scythe and went his way
To hoe his corn, to gather his hay;
And the weed grew safe and strong and tall,
Close by the side of the garden-wall."

I am sure that all the children who have gardens during the summer will agree with the farmer and say, "Good for nothing." This will surely be true if any of the plants were neglected and permitted to mature and scatter their seeds in or near the garden last year. The burdock is a biennial, which means that two years are required for a plant to come to maturity and produce seed. Such a weed is much easier to get rid of than a perennial which lives on from year to year in its roots, like quack grass. It needs only to keep the burdock's blooms from ripening into seed to be certain of its absence the next season, for the roots will die after the plant has blossomed.

The burdock is rather a handsome plant when it can have its own way and grow tall and strong. Its roots are used in medicine, and horses are very fond of the young leaves in the spring. I know one who would leave his oats any day for a handful of tender burdock leaves.

Study a burdock bur. Not only is every bristle hooked at its tip, but its edges are curled inward and slightly roughened. No wonder it catches so easily to the coats of sheep and cattle and to the clothing of any person passing near enough to touch. Animals rub the burs off against fences and tree-trunks and so plant them in new localities,

SUGGESTIONS FOR STUDY.

Every school should have a tripod lens which will not cost more than 50 cents. Through this lens boys and girls will be able to see how wonderfully some plants are made.

Remove one of the burdock hooks and look at it through the lens. Notice how sharp the hooks are. If you remove one of the seeds you will find two kinds of hairs present, some situated on the end of the seed and others lying among the seeds. You will notice that the hairs on the end of the seed are not so long as those on the dandelion. The dandelion, you know, is carried by the wind and burdock seeds by means of the little hooks on the seed which attach themselves to animals. You see in this way they do not need the little balloons with which the dandelions are furnished.

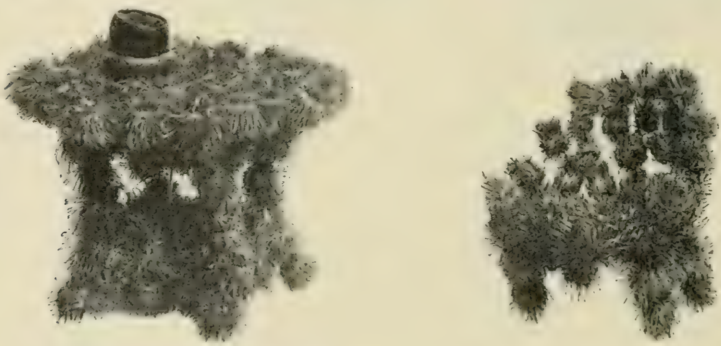

FIG. 1.—*Furniture made from burdocks.*

In one small seed-head of the burdock I counted twenty-six seeds and it was not a very large head. This suggests an example in arithmetic. If there were forty heads in the plant each containing twenty-six seeds, how many plants might be produced? Now you see why burdocks should not be permitted to go to seed on farms, in gardens or along the wayside. Can boys and girls do anything to help get rid of the burdock?

A WINTER BOUQUET.

When you go afield to gather the burdocks, you will find many other plants still standing erect above the snow. Take some of the old stalks back to school for the nature-study table. As you come to look at them more closely you will find some of them wonderfully made.

Notice the teasel. How tall it grows! Can you not see as the wind shakes it back and forth that the seeds will be scattered far from the parent plant? Do you find any seeds on the old teasel stalk at this season?

In studying your winter bouquet notice whether there are any seeds that you think birds might eat these cold days.

DOGS.

As I walk through winter woods I often think of the time when white men did not live here; when forests were dense and wild; and when wolves ran howling on their way through the long, cold nights, But that was long ago. Probably not many of our boys and girls have ever heard or seen a wolf, unless he was a captive. Where have they gone, these wild dog-like animals, and why have they gone?

FIG. 2.—*On guard.*

Foxes, near relatives of wolves, are not so rare. Have you ever seen one traveling along his solitary way? I say solitary way because, as you know, foxes do not hunt in packs as do the wolves. If you live on a farm, perhaps you can tell of a visit a fox has made to your home and whether or no you enjoyed having him there.

We may not be able to see wolves and foxes, but almost everywhere and every day we can see their tame relations,—dogs. I like large dogs best: St. Bernards, mastiffs, great Danes, collies and the like; yet some very small dogs have taken a large place in my life.

Now every one of our boys and girls can tell a dog story and Uncle John will be glad to hear it; but there is something more we want you to do. Since dogs take so important a part in our daily life, we should know more about them. When you write to Uncle John again I hope you can tell at least one new thing that you have learned from your study of dogs this month.

I think one of the first things you should do is to name the kind of dogs that you know. Can you tell a bulldog when you see it? A spaniel? Pointer? Collie? Bloodhound? St. Bernard? Poodle? Greyhound? Mastiff? Pug? Fox-terrier? Do you suppose all the dogs you see

represent some named breed? Or are some of them just "common dogs," as most horses are "common horses" and not coachers or roadsters or draft horses? Write Uncle John a letter describing some kind of dog. Can you describe it so that he could tell that kind of dog when he saw it, even though he had never seen this breed before?

FIG. 3.—*The collie.*

If you could own a dog, would you like a bloodhound with its wise, almost human face? A mastiff? A large and handsome St. Bernard? A greyhound that runs so fast and sees so far? A collie with its beautiful head and thick, rough coat? A queer little poodle, so quick to learn all sorts of tricks? A setter? A fierce bulldog? As you think about these dogs, compare them with those that you have known.

OTHER SUGGESTIONS FOR STUDY.

1. Give your dog a bone and notice how he holds it.

2. How does a dog drink?

3. Does he sleep much in the daytime? What position does he most often take when he lies down? Does he always choose the same piace in which to rest? Can you give a reason for his choice?

4. Have you ever tried to make a nice bed for your dog and has he always arranged it afterward to suit himself? Do you know whether wolves make beds for themselves in the forest?

5. You should keep fresh straw for your dog's bed and have his kennel whitewashed inside once in awhile; why?

6. Watch your dog hide a bone. How does he do it?

7. Which dog is most valuable in the farmhouse? Give a reason for your answer.

FIG. 4.—*St. Bernard.*

8. If you live on a farm, you may know what a shepherd dog is. What breed is the shepherd dog?

ENGLISH SPARROWS.

When we speak of sparrows we usually think of the English sparrow, the only one of its kind that has a bad reputation. If boys and girls were to study the habits of the sparrows they would be surprised to learn how much good many of them do on the farm. Perhaps some boys and girls do not know that there are a great many different kinds of sparrows. If you become a good bird student you may some day know twenty or more different ones. Some that come into my mind are: The Snowflake, Lapland Longspur, Vesper, Grasshopper, Lark, English, White-crowned, White-throated, Chipping, Junco, Song, Swamp, Fox, and there are a number of others.

FIG. 5.—*Which dog looks most like a wolf?*

Many of these little birds look quite similar when you see them out-of-doors, but when you begin to be a close observer you will find there is a difference in their size, shape, color, tricks and manners. Now in the wintertime I want you to begin your study of the English sparrow. Very little can be said in his favor, to be sure, but we as Naturalists do not want anyone to tell us why he has become a nuisance. We want to find out for ourselves. Therefore let us consider the following suggestions for study:

1. Are English sparrows sociable birds or do you find them alone? There is a difference in the marking of the male and female English sparrow; see whether you can tell Uncle John what this difference is.

2. Where have you seen English sparrows feeding?

3. Where have you seen them make their homes? Try to find the nest of an English sparrow and notice whether it is neatly or carelessly made.

4. One of the chief reasons sparrows are a nuisance on a farm is that they are grain eating birds. What grains have you ever seen them eating?

5. Birds are sometimes valuable because they eat the seeds of injurious weeds. What weed seeds have you ever seen the English sparrow eat?

6. Birds are often of value because they eat injurious insects; what insects have you seen the English sparrow eat? Have you noticed them feeding on weeds in public parks?

Photograph by G. W. Morgan.

FIG. 6.—*Studying potatoes.*

POTATOES AND HOW THEY GROW.

Every plant is interesting; the wayside weeds, the house plants, farm crops, everything that grows has a life-story well worth the learning. When you plant a seed in the earth and watch the first leaves come up you have begun a line of study that will give you a great deal of pleasure and profit through the years. In order to obtain certain plants we do not sow seeds. Sometimes we plant a part of the stem which is grown under ground, as in the potato. On this potato you will find buds. Since it is the stem this is what you would expect to find. Take the stems of trees and shrubs about you, and you will see

that they have buds. You will notice also that these buds are being protected during the winter.

Would it not be interesting in this winter weather to watch a potato grow right on your desk? The warm room may encourage the buds to begin their growth, and if you are patient you will see how the potato starts its growth. Your teacher may not want you to leave the potato on your desk all the time. If not, you might put your name on a slip of paper and pin it to the potato; then when you are doing your other work, it may be left on the window-sill or on the Nature-Study table.

People who grow potatoes try to learn all they can about them so that they will have the very best potato crop. Some of the things that potato growers want to know would be interesting to young persons in their study. Let me suggest some things for you to notice as you make observations on the potato.

SUGGESTIONS FOR STUDY.

For a lesson on the potato every child should have three potatoes, to be used for observation for several days; one that you may cut open, one to be kept for daily observation, and one that you may take home and ask mother to cook for you.

First, take the potato you intend to watch until it begins to grow: Is its shape oval, cylindrical, regular or irregular? Is it large, medium, or small? Notice the eyes. Are they deep in the potato or shallow? Are they oval, narrow, or long? Are the eyes large or small? Are they distributed all over the potato or at one end? What is the color of the potato; yellowish-white, pink, or russet? Is the skin glossy-smooth or dull-smooth? Notice whether the potato you have is clean. Is the skin cracked or not cracked? Sometimes when a potato is placed on your plate it is not good. Does the potato on your desk seem to have any diseased places that you think would make it undesirable when cooked?

Now take the potato that you intend to cut. Observe the flesh. Is it white, yellowish, pink, or blue? With your leaflet before you notice all the above questions that can be answered by observation of the potato you intend to take home to be cooked. When it is served notice as you eat it whether it is soggy or mealy and whether you like the flavor. Some good potatoes are spoiled in the cooking. If you find that the potato is mealy and tastes good ask mother how it was cooked.

NUTS ON THE NATURE-STUDY TABLE.

During the autumn days many boys and girls collected nuts for the Nature-Study table as they were requested to do. Now in the winter you may be able to sit by the table awhile and study these nuts. If

you have collected some with the burs and some without, arrange them as nearly as you can as they are arranged in the photograph.

How many kinds of hazelnuts have you found? Did the outer covering have a long beak or a short ruffled lip? How does the covering divide to release the nut?

Some chestnuts have flat sides, while some are nearly round; how is the fact explained? Have you ever observed squirrels cutting off and dropping chestnutburs on the ground, before frosts have opened them? Do all chestnutburs open with the same number of clefts?

In how many ways do horsechestnuts and their burs differ from the true chestnuts? Why are the *round* horsechestnuts best for sling-shots?

How do you distinguish the bitternut and mockernut from good hickory nuts? How many seams does the outer shell of the hickory nut show?

Do walnut shells have seams like the hickory nut? Do the inner cells and meats of walnuts resemble any other nut? How many nuts can you think of with "two-pronged" meats like a walnut?

FIG. 7.—*Nuts. How many kinds are there?*

QUOTATIONS FOR DECEMBER.

I watch the snow flakes as they fall
On bank and brier and broken wall;
Over the orchard, waste and brown,
All noiselessly they settle down,
Tipping the apple-boughs, and each
Light quivering twig of plum and peach.

. . . .

The ragged bramble, dwarfed and old,
Shrinks like a beggar in the cold;
In surplice white the cedar stands,
And blesses him with priestly hands.

J. T. TROWBRIDGE.

Junior Naturalist Monthly

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ALICE G. McCLOSKEY, Editor.

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THE NATURE-STUDY CORNER.

If I should visit some of our village and rural schools to-day, I am wondering in how many I would find an interesting Nature-Study Corner! Would there be a table on which Junior Naturalists could keep specimens for study? I think there are a great many schools in which this has been done and I am sure there are some young persons who have taken delight, when the other lessons were completed, in spending some time in the Nature-Study Corner.

FIG. 1.—*A rural schoolhouse on the Cornell campus.*

In visiting schools, I suppose I should find many different specimens that have been found afield and have given material for study. Among other things I should expect to find the following: Bird's nests, different kinds of weed seeds, a wasp's nest, specimens of evergreens, different kinds of twigs, small branches of all the trees to which old leaves cling in winter, feathers gathered in the barnyard which gives material for good observation, a record of winter birds seen about the school or home, a record of the weather and, I hope, heads of wheat, ears of

corn, and different kinds of grain. How many things there are that would be worth the while in a Nature-Study Corner!

Now in Fig. 1, you will see the picture of a schoolhouse in which we are going to have a place for young folks to study some interesting things that have to do with the outdoor world. I am sure there are many boys and girls who would like to go to school in this neat, attractive building. Perhaps some day in your school district such a school will be built or, at least, a work room added to the existing building. In the building there are two rooms, one in which the children have their regular lessons, the other in which they study soils, growing plants, live animals, and other interesting things such as you have put in your Nature-Study Corner. When the regular lessons are finished, the children may go into this work room. I suppose, if there were such a room in your school, you would learn your geography, arithmetic, and spelling very rapidly so that you might go into a bright, sunny room in which you might carry on a great many interesting experiments all by yourself.

During the coming months, I am going to publish in the Junior Naturalist Monthly some of the lessons that the children have prepared in the work room of this attractive schoolhouse. You may not have a work room now but, if you use your Nature-Study Corner well, perhaps the people in your district will be willing to provide a room in your school building in which you can experiment along the lines of farm study.

AN APPLE TWIG AND AN APPLE.

L. H. Bailey.

In November I went over into the old apple orchard. The trees were bare. The wind had carried the leaves into heaps in the hollows and along the fences. Here and there a cold-blue wild aster still bloomed. A chipmunk chittered into a stone pile.

I noticed many frost-bitten apples still clinging to the limbs. There were decayed ones on the ground. There were several small piles of fruit, that the owner had neglected, lying under the trees, and they were now worthless. I thought that there had been much loss of fruit, and I wondered why. If the fruit-grower had not made a profit from the trees, perhaps the reason was partly his own.

Not all the apples still clinging to the trees were frost-bitten and decayed. I saw many small apples, no larger than the end of my finger, standing stiff on their stems. Plainly these were apples that had died when they were young. I wondered why.

I took a branch home and photographed it. You have the engraving in Fig. 2. Note that there are three dead young apples at the tip of one

Fig. 2.—*This is the branch that tried and failed.*

Fig. 3.—*These are the flowers that make the apples. How many clusters are there?*

branch. Each apple came from a single flower. These flowers grew in a cluster. There were three other flowers in this cluster, for I could see the scars where they fell off.

But why did these three fruits die? The whole branch on which they grew looked to be only half alive. I believe that it did not have vigor enough to cause the fruit to grow and ripen. If this were not the cause, then some insect or disease killed the young apples, for apples, as well as people, have disease.

Beneath the three dead apples, is still another dead one. Notice how shriveled and dried it is, and how the snows and rains have beaten away the little leaves from its tip. The three uppermost apples grew in 1902; but this apple grew in some previous year. If I should show you the branch itself, I could make you see in just what year this little apple was born, and just what this branch has tried to do every year since. This branch has tried its best to bear apples, but the fruit-grower has not given it food enough, nor kept the enemies and diseases away.

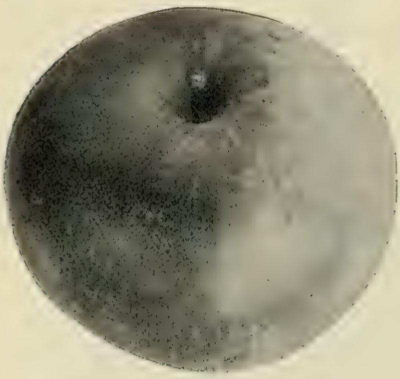


FIG. 4.—*The Baldwin apple. How many kinds of apples do you know?*

The lesson that I got from my walk was this: If the apples were not good and abundant it was not the fault of the trees, for they had done their part.

In the cellar at home we have apples. I like to go into the cellar at night with a lantern, and pick apples from this box and that,—plump and big and round—and eat them where I stand. They are crisp and cool, and the flesh snaps when I bite it and the juice is as fresh as the water from a spring. There are many kinds of them, each kind known by its own name, and some are red and some are green, some are round and some are long, some are good and some are poor.

Over and over, these apples in the cellar have been sorted, until only the good ones are supposed to remain. Yet now and then I find a decayed heart or a hollow place. The last one I picked up was fair and handsome on the outside, but a black place and a little "sawdust" in the blossom end made me suspicious of it. I cut it open. Here is what I found (Fig. 6). Someone else had found the apple before I had. Last summer a little moth had laid an egg on the growing apple, a worm had come from the egg and had eaten and eaten into the apple, burrowing through the core, until at last it was full grown, as shown in the picture. Now it is preparing to escape. It has eaten a hole through the side

of the apple, but has plugged up the hole until it is full ready to leave. When it leaves it will crawl into a crack or crevice somewhere, and next spring change into a pupa and finally come forth a small dun-gray moth. This moth will lay the eggs and then die; and thus will be completed the eventful life of the codlin moth, from egg to worm and pupa and moth. But in doing all this the insect has spoiled the apple. The insect acts as if the apple belongs to him, but I think the apple belongs to me. Wonder which is right?

FIG. 5.—*The same Baldwin apple cut in two.*

Some of these apples are sound and solid on the inside, but they have hard blackish spots on the outside (Fig. 7). This is a disease—the apple-scab. This scab is caused by minute plants and these plants also claim the apple as their own. There are ways by means of which the apple-grower is able to destroy the codlin-moth and the apple-scab; and thereby he secures fair and sound apples.

Insects and diseases and men are all fighting to own the apple.

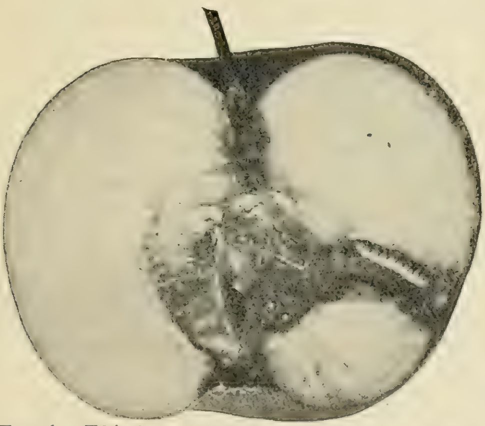


FIG. 6.—*This is an apple in which a worm made its home.*

TEN THINGS TO LEARN FROM AN APPLE.

When you write your dues to Uncle John on the apple, answer as many of the following questions as you can. You can get the answers from an apple itself. He does not want you to ask anyone for the answers:

1. How much of the apple is occupied by the core?
2. How many parts or compartments are there in the core?
3. How many seeds are there in each part?
4. Which way do the seeds point?
5. Are the seeds attached or joined to any part of the core? Explain.
6. What do you see in the blossom end of the apple?
7. What do you see in the opposite end?
8. Is there any connection between the blossom end and the core?

9. Find a wormy apple and see if you can make out where the worm left the apple. Perhaps you can make a drawing. To do this, cut the apple in two. Press the cut surface on a piece of paper. When the apple is removed, you can trace out the marks.

10. When you hold an apple in your hand, see which way it looks to be bigger, lengthwise or crosswise. Then cut it in two lengthwise, measure it each way, and see which diameter is the greater.

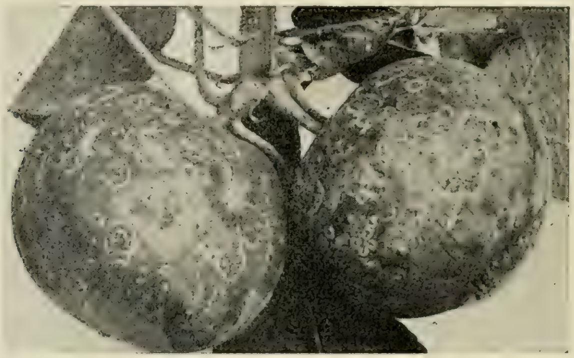


FIG. 7.—*These are apples on which other plants are living. The apple-scab.*

CARROTS IN THE SCHOOLROOM.

ADA E. GEORGIA.

Boys and girls have no idea how interesting some of the large fleshy roots, like the turnip, beet and carrot are. They are excellent for schoolroom observation, for their stored up food is so great that they grow readily when given moisture and warmth. They will stand changes in temperature, too. Cool fires from Friday to Monday will not prevent them from being green and cheerful in appearance when more tender plants would probably die.

We wish you would plan to study some of the roots, particularly the carrot. You may carry on several experiments at once: A short pudgy root may be potted and its growth watched: A large thick one may be cut off near the middle, and the upper end hollowed out, leaving about half an inch of shell; fill with water or a bit of wet sponge in which grass-seed may be sown, and hang in the window like a hanging basket. The leaves will grow and, turning upward, hide the yellow sides of the basket. Do not forget to water daily for this will be needed.

While waiting for leaves to study, observe the roots. The first thing one notices is the bright orange color. It looks good to eat and does not

belie its looks. Taste it and note its sweetness; it is one of the plants from which sugar may be extracted, like the corn stalk and the beet. Sugary foods make heat and fat and that is why the carrot is such good winter food for stock. Observe the fine, thread-like roots fringing the sides and reaching out from the tip of the main root; or if they have been cleaned off from your specimen, you can see the dimples from which they grew. These are the "working-roots," reaching out on all sides for food to send up to the leaves, to help make starch for storage in the big main root.

Cut a root across and lengthwise. Notice the lighter colored and more fibrous central part, separated from the orange-colored outer section by a faint green line. Observe that wherever a rootlet springs, there is a pin-like fiber within the root which reaches to its center. Carefully peel off a bit of the skin and note its extreme thinness and lack of color, like gray tissue paper.

When the leaves have come forth, pick one of the largest; note the slender tapering stem, beautifully fluted on the under part, and with deeply grooved upper side, forming a trough to gather rain and dew. Note the strong fibers—like fiddle-strings—beneath the fluted surface of the stem, giving it strength to hold itself so gracefully upright. Count the leaflets on each stem, and observe that they are much divided. What are such divided leaves called? Does the number vary on different stems? Taste the leaf; what an unpleasant taste. Do you think the disagreeable taste helps the plant by keeping enemies from molesting it while it manufactures starch for storing in the large fleshy root which should blossom and form seed next year? For the carrot is a biennial, growing the first year only leaves, and the big root which lives through the winter and matures seed the second year.

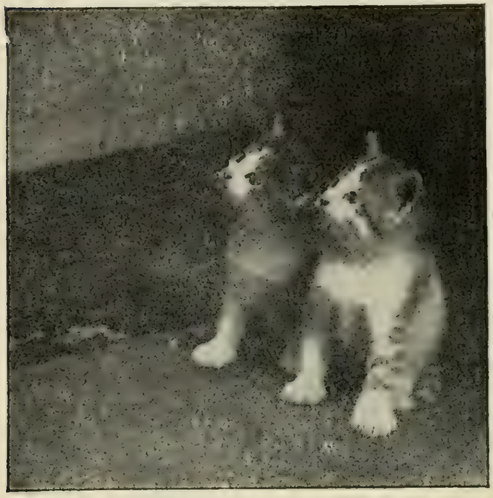
CATS.

"Close by the jolly fire I sit
To warm my frozen bones a bit."
—ROBERT LOUIS STEVENSON.

It is cold out-of-doors these March nights. The wind howls about the eaves and rattles the window blinds. You sit before the fire and think that it is very nice to be at home. The gray kitten comes in lazily, yawns, stretches, and then sits beside you. She does not like the cold. None of her family like it. Lions, tigers, and cats enjoy life best in the warmer lands.

We want you to think about the gray kitten this month. If you have cared for her tenderly all the days that you have known her, she

will give you many opportunities to study her ways. Cats, you know, are valuable farm hands. Let us try to understand them better that we may make them more comfortable and at the same time more useful.



Good comrades.

A long time ago I owned a gray kitten, one of the most interesting of her kind that has come into my life. She was a little waif that I met on the highway one winter night and, although I tried to prevent her, she insisted on going my way. When I reached home, there she was beside me. It was so cold that I did not like to leave her out-of-doors, and the next day I could not learn where her home had been.

We became very friendly, this little gray kitten and I, and she followed me about as faithfully as a dog. One way in which she showed her desire for my companionship will probably interest boys and girls. It happened that for several weeks I was detained in the city until after dark, and one night, as I was returning to my home I found her standing on a corner about four blocks from the house. I picked up the little wanderer, covered her with my cape, and carried her home. The next night she was in the same place waiting for me, and this continued for weeks. Even on cold, stormy nights, the little, shivering figure stood by the railroad crossing, always on time.

When you write to Uncle John, tell him something about your cat. He will be interested to know how long she has lived with you, and whether you enjoy her more than your other household pets. He will also like to have you learn something about her that you have never known before. The following suggestions may help you:

1. There are two great classes to which cats belong, the long haired and the short haired. In which class would you place your cat?

2. Is she friendly with the members of your family? If not, what do you think you can do to make her feel happy when persons are about?

3. Notice whether she likes to do the same things each day.

4. Give your cat a bone with some meat on it. How does she hold it? Does she chew the meat? How does her tongue feel when she licks your hand? What do you feed your cat?

5. Notice how she uses her paws and her tongue when she cleans herself? Why does she keep herself clean?

6. How can pussy defend herself from dogs?

7. Feel the underside of her foot. When you do this, do you feel her claws? If not, why? Does a dog have claws. What does a horse have instead of claws?

8. Notice whether pussy eats slowly. Some animals hunt in packs, and when they eat, they devour their food rapidly lest their companions may take it from them. What do you think about cats? Do they go alone in search of food? Have you ever noticed whether they are in a great hurry to get rid of their food?

9. The cat, you know, belongs to the same family as the lion, which prowls at night, very often traveling by twilight. Do you think the cat enjoys hunting by twilight?

10. Watch your cat when she is walking on the snow. Does she seem to enjoy it? Observe that in walking, pussy's hind feet fall easily and exactly upon the tracks made by the front ones. This is what makes the cats of the wild so noiseless when stalking their prey; they choose by sight where to place the forepaws, and the hind ones seem of themselves to find the same spot.

11. Why is the cat a useful farm hand?

12. Every year the government appropriates money to maintain cats in the post offices and public buildings. Why?

13. It is said that well-fed cats are the best mousers; what do you think about this?

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ALICE G. McCLOSKEY, Editor.

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GARDEN NOTES.

Photo. by G. H. Morgan.

FIG. 1.—*Entrance to the Ithaca School Gardens.*

ALTHOUGH it is not yet the end of February, it is time for us to begin to think about our gardens. Every American boy and girl should come to know and love a garden; and since Uncle John tells you that it will really pay to make the effort to have one, I am sure you will start in this year. Over the ocean in England, nearly all children have gardens; in fact, I suppose they would not think the springtime had really come unless they planted green things and watched them growing.

In Ithaca, boys and girls have school gardens and there is no reason why in every city, in every village, and in every rural district there should not be an attractive and thriving garden connected with the public school. Have you one? If so, tell us about it.

Now you will ask, "What can we do in February in preparation for our garden?" This is a good time of the year to make plans, for one must always look ahead and think a great deal on any project if he would make it finished and satisfactory. Is there a piece of ground connected with your school building which might be used for such a purpose? If so, we wish you would send us a plan of it and tell us why you think it would be a good place. Make a drawing of your entire school ground, locating the garden so that we may understand your plan. When you tell us about your garden, tell us also what improvements you hope to make this spring time in the surroundings of your school.

The children in the Ithaca schools are already deciding on the things to plant and you may want to do the same. Ask your teacher to send to any good seed firm for a catalog. These are advertised in rural papers. It is always a great pleasure to me, when the wind is blowing and the snow is flying, to look over a catalog of seeds that I may want to plant on a future sweet spring day. I then have visions of onions peeping above the soil, of neat rows of radishes with their pretty, green leaves; and to my study seem to come odors of sweet alyssum and of mignonette.

If you have selected a piece of ground, divide it off into sections in your plan, so that each pupil may be given an individual garden. There should be neat paths between these gardens and perhaps an attractive border of flowers that will bloom in autumn when school first opens. This border might be planted and cared for by all the children in the school.

But you will say, "Who will take care of the garden in summer?" If you live very far from the school, of course you cannot go every day to care for it; but it will be worth the while to plant it and I am sure some of the things will be growing in the fall when school begins. In summer, those who live near the school will, I am sure, take care of the borders and weed out the garden beds. At any rate you can grow some early crops that can be harvested before the close of school; radishes, lettuce, onion sets, and many other things which we shall discuss later.

If you know some resident of the village or district in which you live who is a good farmer, ask your teacher to invite him to the school to talk with you about making your garden. He will suggest crops to be grown for the first year so that you may not become discouraged.

Now, in these February days, let us look over the seed catalog and select such early crops as we think will be harvested before the last of June. Then let us select some flowers that will be in blossom when we come back to school in autumn. The school garden at Ithaca was very attractive in the September days when the zinnias, marigolds, phlox, larkspur, and bachelor buttons were in bloom.

We want every boy and girl to make a list of the things he would like to grow in his own small garden plot and send it to Uncle John. Select first those flowers and vegetables that you like best; then select one that you do not know, for each year one should become familiar with a new plant.

THE WILLOW

ADA E. GEORGIA.

Now is the time to study winter buds, for many of them begin to swell and show that they feel the "northing sun" as early as February; and a good way to make the study easy, is to gather small branches and

bring them into the house for forcing in water. The warmth and light of a sunny window will help them to make immediate use of the food which the tree stored away in the summer past, and you may have leaves and blossoms long before the snow is gone out-of-doors.

You will be interested in the study of many kinds of trees, but one of the most attractive, and among the easiest to force, is the willow. There are many kinds, some large trees, and some only shrubs, but all are useful and attractive.

FIG. 2.—*Seed bearing catkins of the willows.*

Observe closely the tree from which you gather twigs, its size, and the color of its bark —it is from the bark that the black willow takes its name. The silky willow's purple twigs and the golden osier's yellow ones will help you in like manner to know them. How many scales in the bud coverings? Do you find any at the very tips of the twigs? As the "pussies" grow some will cover themselves with golden or reddish fuzz according to the kind, and be as dusty as millers. Others will be small, and silvery green, with no dust or fuzz at all, yet apparently on the same kind of twig, though from different trees. They are the same kind of willow and I hope you will remember to watch some of these small green catkins on the growing tree. In June or late in May you will find that the little green catkins have grown large and are covered with rows of tiny pointed pods, which open just as milk weed pods do when ripe, and out float the tiny seeds, each borne up by the silken wings which carry them far from the parent tree.

When your twigs have been only a few days in water you will find that all the willows have put out rootlets and have begun to grow. Even if a twig happens to be wrong end up, if it has plenty of warmth and moisture, the rootlets will often form. This habit of taking root easily makes the willow most useful as a "soil-binder" when planted along the banks of streams that "wash" and overflow in flood-times. It has also other uses; its wood makes charcoal of the finest grain, which is therefore used in the manufacture of gunpowder. Perhaps your mother's clothes-basket or the baby's carriage is made of peeled willow withes, grown for the purpose by "pollarding" or cutting back the tree known as the basket willow. The wooden shoes worn by many of the working people of

Europe are made of willow-wood, which is exceedingly light, though tough when well seasoned. And we must not forget what fine whistles we can make as soon as the bark "slips" on the willows. It would be interesting to observe how long the whistle season lasts, between the time when the bark will "slip" and when it "binds."

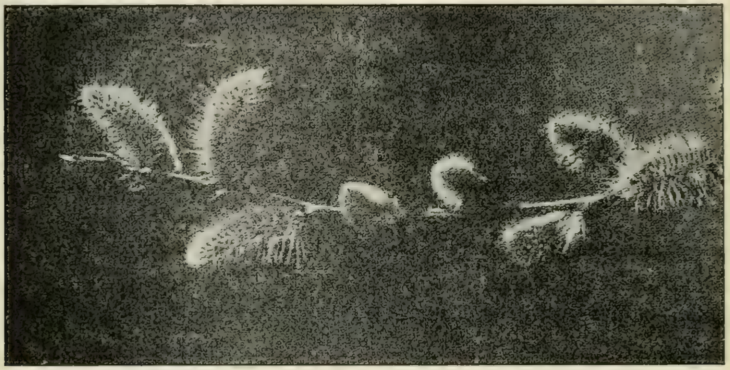

FIG. 3.—*Pollen-bearing catkins of the willow.*

THE ONION.

ADA E. GEORGIA.

Every one knows the onion in its cured state in the market; many are fond of it, either alone or when lending its flavor to foods of duller taste. But few, even of those who cultivate it ever think of it as a lily, or that the lovely "Stars of Bethlehem" that open their white or azure blossoms in the time of daffodils, are its near relatives. They and the onion have the same family name, *Allium.*

But it is the poor relation, the Cinderella of the lily family; valued only for its usefulness, and grown for profit. In the Bermuda Islands, where almost the whole industry is employed in the growing of two lilies —the Easter lily and the onion—it is the latter which pays the better and is valued most.

Any boy or girl can raise onions; but to raise good ones, that pay for themselves and are a pride to the grower, demands careful thought, and hard work. But when such care and labor is spent upon them how they do reward it! Grown-ups expect their acres to yield from five hundred to eight hundred bushels each, and I know of one boy who sold his little garden crop of onions for eleven dollars, more than all his other vegetables were worth.

Onions are raised from seed, from "sets," which are small bulbs formed underground by the "potato" or "multiplier" onions; from

" tops " which are little bulblets that grow on the flower-stalk instead of blossoms; and from the multipliers which produce the " sets."

Sets, tops, and multipliers are planted to obtain the early crop of " bunch onions " for the spring markets. A boy who has a bed of them for sale at a " nickel a bunch " is quite a capitalist. The main fall crop is grown from seed. Seeds should be " tested " before planting. They may be sprouted between folds of damp-cotton or blotting-paper, and if the shoot of blade and root is not strong and vigorous, the seed should be thrown away for it will not produce big profitable bulbs. Only the best seed is good enough. Next month we shall give definite directions for testing seeds.

The finest crops are obtained by sowing seed early in the year under glass, and transplanting when the ground is warm enough in the spring, but few boys and girls will be able to get such a start for their bulbs. A deep " flat " in a sunny window, however, would supply enough to set a good sized bed in the garden.

QUESTIONS ON THE ONION.

1. What parts of the onion convinces you that it is a lily?
2. Describe the root of an onion.
3. Describe an onion leaf.
4. Where do the new leaves form as the onion grows?
5. What advantage to the plant are its hollow leaves?
6. Do onions blossom the same season that the seed is sown?
7. Cut a cross-section of a " multiplier " and an ordinary onion and tell how they differ.
8. Observe that the veinings on each layer of the bulb extend upward on the leaves. Is not the bulb then a swollen modification of the leaves formed for the protection and food of the blossom bud within?
9. Have you ever found any wild relatives of the onion? Wild leeks in the woods, or the field and meadow garlics which taint the milk when eaten by cows in pasture. How do they differ from the onion in leaf, blossom or bulb? These are questions that may come into your mind later in the year.

PIGEONS AS PLAYFELLOWS.

All boys and girls should have pets. To love and care for something that is happier for your love and care is worth the while. Most young folks have dogs or cats but very few have other pets.

In a far away country I found the young persons much interested in pigeons and as I watched them with these pretty little playfellows it

came to my mind that Junior Naturalists could learn much and have a great deal of pleasure if there were pigeons round about the school building. I am wondering if it would be possible to do this. It seems to me the experiment might be interesting. If you decide to have pigeons you ought to make the home for them yourselves. In Fig. 5 you will see a very simple pigeon house. The floor space is 15 inches square and the house is 15 inches high. The door, which has a small platform in front, is 6 inches in height. Almost any boy could make such a house and it would do for a beginning.

One can learn a good deal of bird life from pigeons and they are so tame that they become the most friendly kind of playfellows. If you can succeed in getting a pair at nesting time they will probably stay in the house you have made for them.

When you make your school garden you can plant some things for food for the pigeons. They eat millet, oats, rye, corn, peas and barley. I think it would be fun to raise some of these crops for the pigeons that live at the school. Talk this matter over with your teacher and see whether she is willing to experiment with them.

SUGGESTIONS FOR OBSERVATION OF PIGEONS.

FIG. 4.—*Favorite nesting place for pigeons.*

1. Note how pigeons drink. Compare the way a pigeon drinks with the way a hen drinks. Perhaps some boy will have a pet pigeon that he will bring to school for a lesson.

2. Describe a pigeon when walking.

3. How many colors can you see on a pigeon?

4. Notice how it flies. Notice the difference in the flight of a pigeon, a crow, and a hawk.

5. The boy or girl who can describe a pigeon accurately will be able to describe wild birds so that they can learn their names. This you will be glad to do. Learn, therefore, to give the colors of the head, the neck, the breast, the back, the tail, the beak, the eyes, the legs, the feet, and claws of the pigeon.

6. What enemies have pigeons?

TO THE TEACHER.

We are using some of our former lessons, since they cover the subjects outlined in the New York State syllabus. Even if many teachers have taken up these lessons in previous years, I am sure they will not have entirely covered the ground suggested in the many questions.

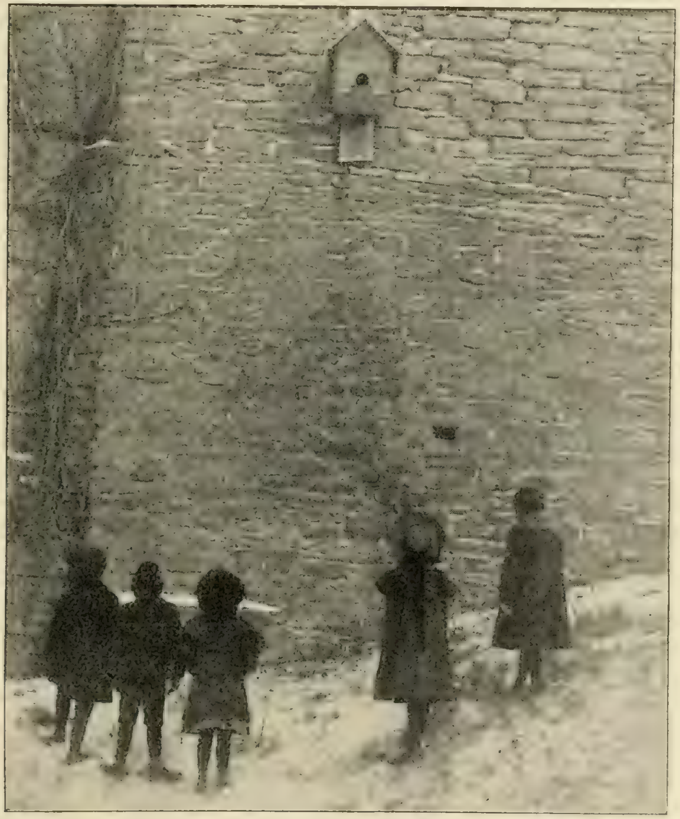

FIG. 5.—*A pigeon house. What criticisms have you to make in regard to it?*

We cannot ask too often that the children prepare their Nature-Study lessons from the actual study of outdoor things. Books are always valuable for reference in their work, but of little or no value educationally to the child if used for the purpose of getting information. One of the most important factors in Nature-Study is, that the child learns to see. Let him cultivate his powers of observation by actual contact with live material.

Encourage the Junior Naturalist to write letters to Uncle John. Give them an interest in the personality of the man to whom they write. He is always glad to get these letters, which are filed carefully. Whenever the children have letter writing for their language work, why not let them write to a real person about real things?

The editor of this leaflet has been a teacher and has taught a number of years in many grades. She knows the difficulties that come up daily in the schoolroom. She knows that all teachers who have made an effort to give their children an opportunity to know the out-of-doors have made sacrifices to do this. Write to her freely of your difficulties. As far as she is able, she will gladly act as counselor and friend in the matter of the education of little children.

Address your letter to Alice G. McCloskey, Cornell University, Ithaca, N. Y.

THE NATURE-STUDY CORNER.

We have told you about the little work room in our rural school on the Campus. We hope in time that every rural schoolhouse will have a place in which children can study out-of-door things and perform simple experiments that will teach them to know more about their natural surroundings. This work room cannot be provided yet in all schools but we have suggested that in every building there should be one corner set off for Nature-Study materials and for experimental work. In many rural schools this has been done and we have been very much surprised indeed at the progress the young folks have made. Following are letters that we have received telling about the efforts that have been made to have this work successful:

ELIZABETHTOWN, N. Y.

Dear Uncle John:

We have a Junior Naturalist corner where we have twenty-eight kinds of wood and some birds' nests. One is a chimney swallow's nest. It looks so funny. It is all glued together with juices from the bird's mouth and another nest is lined with birch bark.

We have two or three kinds of fungus. We have Uncle John's picture framed in birch bark and we have some birds' pictures.

We have a good many in the club this year. I have been in the club for three years. This year I am the president of the club.

From the president
DOROTHY WOODRUFF

My teacher's name is Miss Shepson.

ATWATER, N. Y.

Dear Uncle John:

The "Club" have elected new officers and have asked me to be their Corresponding Sec'ty and Treasurer.

They have raised through their collections and a small Christmas gift from their teacher enough to pay for the curtain which encloses their "Nature-Study Corner," enough to send all their letters this year, to buy the Cornell Leaflets and buy the tripod lens spoken of in last month's lesson.

Please direct us in buying a "Lens." Can we get them in Ithaca by mail referring to the Cornell Nature-Study to insure a good one at fifty cents or seventy-five cents, not more? If so, please send address.

My fourth and fifth grades tried the seventh grade Examination yesterday passing from eighty per cent. to ninety per cent. nearly as well as the seventh. This pleased me. TEACHER.

Junior Naturalist Monthly

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ALICE G. McCLOSKEY, Editor.

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BEECH.

"Like beggared princes of the wood,
In silver rags the birches stood,
The hemlocks, lordly counsellors,
Were dumb; the sturdy servitors,
In beechen jackets, patched and gray
Seemed waiting spellbound all the day
That low entrancing note to hear,—
Pe-wee! Pe-wee! Peer!"—*Trowbridge.*

MANY times children are familiar with trees in spring, summer, and autumn but they have no knowledge of them in winter; yet trees in winter give as much delight to those who know them as they do in summer. Oftentimes I have gone out on a winter day with my botany can and filled it with twigs for the pleasure that the colors and forms gave me. I always cut the twigs carefully so as not to injure the tree.

Not long since I gathered a twig from the beech tree. The twigs of these trees always have a very characteristic appearance because of the long, slender buds. I wish some boy or girl would get a good sized twig of the beech for study and place it on the nature-study table. Note whether the buds open and if so how. Observe also the rings showing where the branches started in previous years. Compare these rings with those on an apple twig. How would you say they differ?

If you do not know a beech tree when you see it and if your teacher does not know it, we shall be glad to learn how you went to work to find

out whether there are any beech trees in your vicinity. I have rarely gone into a village or rural community in which I did not find some person who knew the trees. Is there not a farmer in your community who knows the trees and will come to the school and talk about them some day? This will help boys and girls a great deal.

Observe working roots and boring tips.

Beginning with the very first days of spring, look for forms of life that you find in connection with the trees you have studied. Notice whether there are any insects about the trees; whether the birds build their nests in them; whether the squirrels play about the branches. You will find some interesting life in connection with most trees. I associate one of the most beautiful moths that I know with beech woods. When its wings are closed it looks like a part of the bark of the beech tree, while the under wings are very beautifully colored. The fact that the wings resemble the bark protects this moth from the birds. Another association that I have with beech woods is the song of the Pe-wee. I wish you would learn the little poem at the beginning of this lesson and sometime go into the beech wood

> "That low entrancing note to hear,—
> Pe-wee! Pe-wee! Peer!"

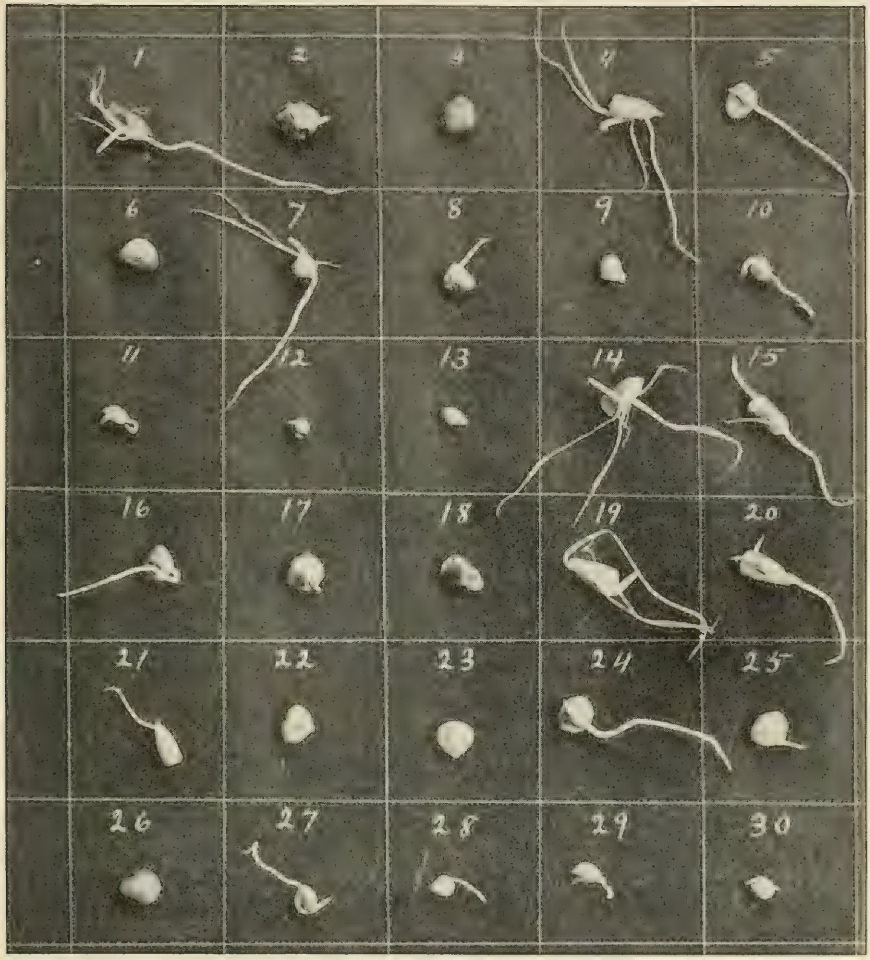
Keep a record this year of all the places in which you hear a Pe-wee.

TESTING SEEDS.

ADA E. GEORGIA.

Plowing, harrowing, rolling, drilling in the seed, cultivating and harvesting in big fields measured by acres; spading, hoeing, raking, marking by line, and sowing seed by hand in little gardens, are all very hard work, though we enjoy doing it very much when we think of the large rewards. For the rewards are large, and the real wealth of any land lies in what grows from its soil. Even boys and girls, if they think a moment, can see that this must be true.

But it is harder still to see our labor wasted, and sometimes, after all the work of preparation, the seed does not "come up," and we have to try again, with the same crop, or if too late for that, with some other crop.



The test shows plainly that some of the seed would not have grown and that some is very good.

Would it not be well to be certain that the seed is good before planting it in field or garden? This is what wise farmers are doing and they find it pays.

The seeds illustrated here were tested in a contrivance made of two square, five-cent cake-tins such as are used for layer cakes. A double layer of cotton wadding was placed on the bottom to absorb and retain moisture; then a sheet of blotting-paper, marked off in numbered squares, another sheet of blotting-paper above the seeds and the whole covered with another tin of the same size, or a thin board—anything to exclude the light, for seeds sprout best in the dark.

Seeds from a dozen different ears of corn, and from several packets of onion seed were carefully numbered to match the squares in the tester and a record made. Then they were put in a warm place, kept moist, and watched from day to day. All had exactly the same conditions and treatment, but just see the difference in their behavior!

In taking the seed from the corn, some were the small, unformed kernels at the tip of the ear, others from the stem end, and others from the center of the ear. There were different varieties: pop-corn, sweet corn, and yellow and white field corn.

Study the pictures. You would know that the packet of onion seed marked No. 19 would be worthless to plant. No. 18 has but one sprout in five, others are feebly putting forth, but on Nos. 6 and 7 every seed shows vigorous growth. Onion seeds vary greatly in power to grow and it is a very unwise farmer who plants them without testing.

Of the corn, Nos. 7, 8, 9 and 10 were kernels from butts and tips of different ears. Three have sprouted, but only one shows vigor. From ears looking equally good 24 and 25 were taken but one has germinated more swiftly than its neighbor, and with a stronger shoot. I took 14 and 15 from ears of yellow Western corn, 19 and 20 from white, but all four are deep-meated kernels, sixteen rows to the ear. There is no doubt of their vigor. The pop-corn was a two year old ear which had lain drying in a drawer. I dare say it would have popped much better than

Different results from different packets of seed, all treated alike.

it has grown. Of the six rice-like kernels which you see, two were from the tip of the ear, two from the stem end, and two from the center; all but one having sprouted though with little vigor. No. 4, from an especially fine ear of white Western corn, has been photographed "life size," that you might see the fine fuzzy "working" roots which take up the food from the soil; the pointed, ivory-like, boring tips by which the roots force their way into the earth; and the strong, up-springing shoot which would grow to be a tall corn plant and bear from three to a half dozen ears of corn as fine as itself, perhaps. (Page 2.)

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ALICE G. McCLOSKEY, Editor.

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THE HEPATICA.

"All the woodland path is broken
By warm tints along the way,
And the low and sunny slope
Is alive with sudden hope
When there comes the silent token
Of an April day,
Blue hepatica."

—*Dora Read Goodale.*

FOR SUMMER work in Nature Study, there is one thing that we want our boys and girls to plan for another year; that is a wild garden. Have some place on the school ground that will contain all the different kinds of spring blossoms that can be found in the nearby woods and waysides.

It is not best to gather wild plants while they are in blossom. If you find a thrifty hepatica or Jack-in-the-pulpit or trillium, place a wooden label beside it with your name or the name of your school on it. Then in the fall take it up and plant it in your garden and the next spring it will probably blossom.

The hepatica is one of the plants that, doubtless, you will all find. It is beloved by young folks and old. You might take one plant into the schoolroom this year so that you may become familiar with it. Do not uproot wild flowers needlessly.

Perhaps instead of bringing hepaticas to school you can take a little trip into the woods some day. If so, take these Leaflets with you and see how many of the following questions you can answer:

1. Where do hepaticas grow, in sunny or shady places? In which season do they get the most sunlight?

2. Watch the first sign of life in the plant. Do the new leaves or the flowers come first?

3. Look at the hepatica blossom a long time. How many different parts can you see in it? Whether you know the names of these parts now does not matter. I want you to see them.

4. Notice the three small green, leaf-like parts that are around the flower-bud. As the flower opens see whether they are a part of it, or whether they are a little way from it on the stem.

5. Observe the stem closely. Is it short or long? Hairy or smooth?

6. As the new leaves appear, find out whether they are fuzzy on the inside as well as on the outside. Notice how they are rolled up and watch them unroll.

7. In how many different colors do you find hepaticas?

8. Do some smell sweeter than others? If so, does color seem to have anything to do with it?

9. Look at a hepatica plant at night or very late in the afternoon. Also watch it early in the morning and in cloudy weather. Then look at it in bright sunshine. Do you see any change in the flowers? I think you will discover something of much interest.

10. Seed-time among hepaticas is very interesting. Notice what becomes of the three small, leaf-like parts that were underneath the flower. How many seeds are there?

11. How long do you think the leaves of hepatica remain on the plant? Do you suppose they remain green all winter?

12. What becomes of the hepatica plant after it blossoms? Did you ever see one in summer? Describe.

PREPARING FOR THE GARDEN.

ADA E. GEORGIA.

Spring always seems a loiterer, and when she really comes, finds us such a lot of work to do. But it is fun if it is only out-of-doors. As soon as the snow and the frost has left the earth let us begin to get the ground ready for our garden.

First, we will pick off all the sticks, stones, and rubbish of all kinds. Even though it is too early to plant anything but sweet peas, we will turn over the soil and let Jack Frost crumble and mellow it for us, and perhaps kill some harmful grubs and worms which may be waiting for the first green growths of spring. If around the fences there are any neglected weed stalks we will carefully burn them lest they may contain similar enemies. The potato stalk-weevil sometimes lives over the winter in the joints of horse-nettle and ground-cherry.

Let us sow our sweet peas first, in a row by themselves, not less than four inches deep, and we will make their bed as mellow as the cold earth will allow. In a few days we will turn the loosened soil again

and make it fine and smooth with rake and hoe. Then mark off the beds and rows; do not crowd any plant; radish and lettuce need at least eight inches between the rows, peas and beans, fifteen inches, and corn, potatoes and tomatoes from two to three feet. When we have decided where everything is to be, we will first sow the seeds of cold loving plants like peas, beets and radish. We may put in onion "sets" somewhat early too.

From the first to the middle of May, when there is no danger of cold or frost, we will sow seeds of warm loving plants like corn, beans, squash and tomatoes. Perhaps we have some plants ready started in "flats," which may be planted now. Care is needed not to set them too shallow or too deep, and the roots are better to be pruned a little than to be crowded in a wad when transplanted.

When the seed beds have sprouted they will probably be far too thick in the rows. We must thin and thin again, treating the crowding plants like weeds, which are robbers. To keep weeds out and the soil loose so that it will hold moisture is the main part of the gardener's task from this time forward.

Public school children receiving instruction in gardening.

PREPARING FOR GOOD SQUASH PLANTS.

Probably there is not a Junior Naturalist in the country who would not be glad to raise the very finest squash or pumpkin in his community. I am going to tell you one way in which you may be able to have very strong plants. To do this they should have an early start so that the growing season will be long.

In the early springtime, as soon as the ground is in condition to be worked, take a sod with plenty of earth on the under side; turn it upside down and place in a flat or any kind of box; plant your squash or pumpkin in the soil and place it in a dark place until the seeds germinate; then place it in a window and keep it well watered. When your garden is in good condition for planting you can place the sod right into the earth so as not to disturb the roots of the little plants; for squashes, cucumbers, watermelon and the like do not transplant readily. If, however, you place the sod carefully in the earth, packing the new soil about it firmly, the little plants will never know that they have been moved and what a good start they will have! Try this and in the fall let us know what has been accomplished.

You must be sure, however, that the land in which the plants are to grow all summer is very mellow and rich. Good plants will not grow in poor soil. See that the ground is hoed or cultivated frequently, and also that weeds are not allowed to grow.

At work. Notice the pond in the center of the garden. In this pond pupils have placed animal life and plant life that is found in water.

Junior Naturalist Monthly

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ALICE G. McCLOSKEY, Editor.

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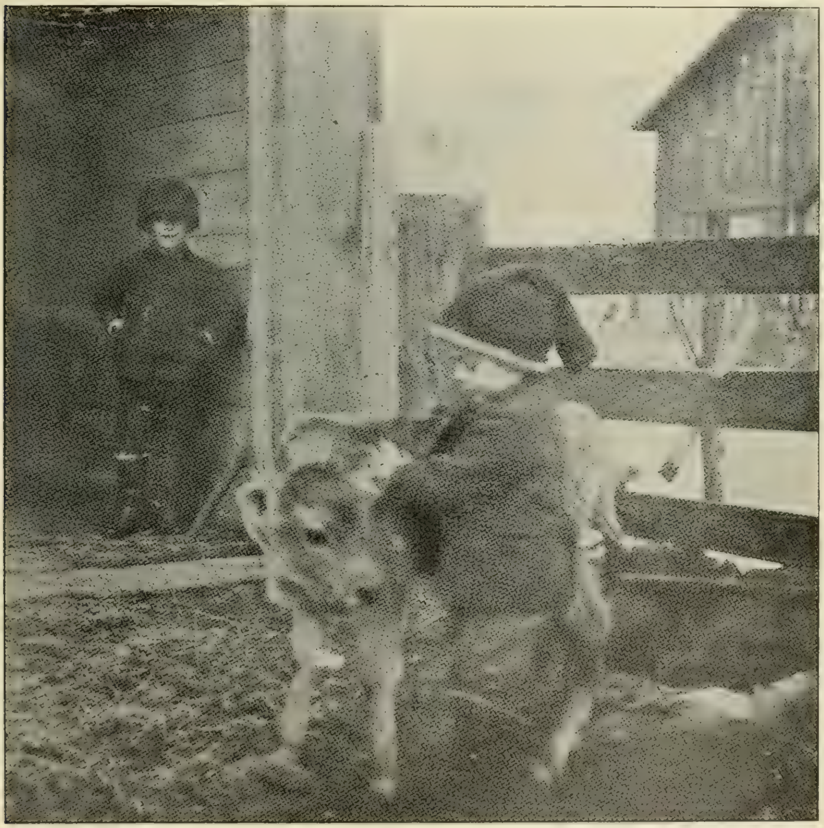
PRIZES FOR JUNIOR NATURALISTS.

Last year we offered ten prizes for the best letters written on a certain number of subjects given in the May issue of the JUNIOR NATU-



The pet calf.

RALIST MONTHLY. The young naturalists wrote on nine of the topics and prizes were awarded to the following boys and girls:

Irene Swanson, R. F. D. No. 80, Jamestown, N. Y., George C. Duer, Liverpool, N. Y., Edith Wright, Ogdensburg, N. Y., Helen Burr, Nor-

wich, N. Y., Ruth Kidder, Jamestown, N. Y., Donald Fox, Avoca, N. Y., Grace Barringer, Middleburgh, N. Y., Elsie Phillips, R. F. D. No. 3, Ithaca, N. Y., Donald Homer Tyler, 116 Lake Ave., Albany, N. Y.

This year we shall offer ten prizes consisting of books, and we hope that every boy and girl will select one of the topics for a letter or composition which he will send to Uncle John before October 15. The letters that took the prizes last year were not written hastily, I am sure. Many of them were received late in the year and showed that the children had studied the subject during the summer. I would advise you, therefore, to select some topic from those suggested in this Leaflet and think about it during the coming months. Write the name of the subject with the suggestions given for the study of it in a note-book, and whenever you have found something interesting in connection with it, write the facts briefly. Then when you are ready to send your composition or letter to Uncle John you will have a good many interesting things to tell him. Even if you do not take a prize, this letter will be greatly valued by Uncle John and I am sure you will have learned many things that will be interesting to you through the years. Address all correspondence for the prizes to Miss Alice G. McCloskey, Cornell University, Ithaca, N. Y.

1. *The history of a plant grown by a child from seed to seed.* Tell all the story: Where you obtained the soil; whether you started the seed indoors or in the garden; whether any fertilizer was used; how you cultivated it; the length of time from sowing to first bloom; to seed-time; how many fold was the increase. Any accident or unusual circumstance which was met and overcome.

2. *Ownership and care of some domestic animal by a child.* Sometimes parents, as a reward for assistance in caring for the farm animals, will give a boy or girl a pet lamb from the flock, or a bossy calf, or a little pig, or most valuable of all, a little long-legged colt. If any Junior Naturalist is so fortunate as to become an owner of live-stock in this way, we would be glad to have the story. Tell how you first earned the gift; how you cared for it; whether you trained it in anyway; whether you cared for it in any accident or through an illness; whether it is kept for growth and increase or sold and why. *Note the illustration on Page 1.*

3. *Care and ownership of poultry by children.—Hens, ducks, geese, turkeys.* This is a delightful subject on which we hope to have many letters. Tell whether you began with a clutch of eggs, or one or more fowls; what you fed them, and whether you earned or bought the food yourself, or whether it was given by your parents; whether you built a coop or roost for them; whether they were thrifty or troubled with disease; whether you suffered loss from prowling enemies—skunks,

foxes or mink; from hawks or owls; whether you made any money by sale of eggs or dressed meat or feathers from ducks and geese.

4. *Study of a bird's home life and care of its nestlings.* The boy or girl who succeeds with this topic must be very gentle, but it will be a most interesting and valued report.

Tell when the nest was begun; where built and of what materials; by one or both parents; how long after eggs were laid the young were hatched; whether one or both parents fed them; with what food; how long before the young could fly; how the mother bird kept the nest clean; whether the little birds looked like their parents or not. Best of all, whether you observed any enemies and protected the birds from them.

In the study of bird life I wish you would have in mind the importance of birds in a community. Some persons are very careless in regard to bird life but this is because they are ignorant of the real value of the birds. It is stated by some naturalists that even crows do more good than harm. It may be that you will be able to study crows this year and find out whether this is correct and in what way they are beneficial.

5. *Gardens at home or at school.* Tell the location and size of your garden; how you prepared it; what you sowed and planted; how you cultivated it; what weeds were most troublesome; what was your first harvest; whether the produce was sold or used at home; whether any exhibit of produce was made; whether any gifts of flowers or vegetables were made to any one less fortunate.

6. *Improvement of school grounds.* Last year this topic did not have the interest for our boys and girls that we had hoped it would. We are sure, however, that some school grounds were improved and this year we should like to know about it even though the boys and girls have not been mainly concerned in bringing it about. When you have read over this topic, go out-of-doors and look over the school grounds. How do you think any passerby would be impressed by them? Would he consider that the boys and girls in your school were neat and thrifty, and that they were proud of the building and grounds in which they spend the greater part of their year? Do the school grounds need to be cleaned up; paths made about them and some things planted to give it brightness and make it more attractive?

7. *Plant colonies.* One of the most interesting subjects for nature-study is the way in which plants live together. Some plants find room to grow with others as near neighbors and they seem to get along very nicely indeed. It always interests me to see what plants live together in the woods; along a brook; along the wayside; in the open fields; along the rail fence; in the corner of my garden. When you write about this topic ask your teacher to let you go out-of-doors. You will see plant

colonies beginning to start up now at this season. It would be interesting to make a note of the plants growing in a certain neglected place in the month of May; to ask your teacher to keep this record; to make another in October when you go back to school and then to compare the two. Boys and girls who live in rural districts will find this an easy subject to work up for a prize.

8. *Insects—Harmful and useful.* A careful study of any insect in all the stages of its growth is very interesting. Eggs of butterflies and moths may be discovered on the leaves of trees and weeds and cultivated plants. The caterpillars which hatch may be kept in an insect cage and fed on fresh leaves of the plant on which they are found till the pupæ are formed and the butterflies or moths appear. Or the life of a bee or a wasp may be studied. Tell all the points you observe, and the part you cannot understand.

9. *What farm crop most interested you during the summer?* Tell to what extent the crop is grown in your vicinity. Has the crop been newly introduced, like alfalfa? Tell how it is planted; cultivated; harvested; whether it has any strong enemies or diseases which must be fought; with what remedies; how it is prepared for market. Does it help to feed or clothe persons?

The prize letter on farm crops last year was written on the potato and was very excellent indeed. The writer showed that he had really studied his subject and we were well pleased with his letter. You see what a wide range of subjects you will have to choose from if you live in the country.

10. *What you have done to interest others in nature-study.* In what way have you tried to help others to see the wonders found in common things? If you have learned something new about a flower or wood-folk of any kind, teach someone else what you have learned and tell us the circumstances. If you have learned to know trees, why not teach someone who does not know them? It may be that you have learned about some of the insect pests such as the Peach borer or Tussock moth. Do other boys and girls in your vicinity know these insects and how much harm they do? Why not help your neighbors to get rid of them? You will not only be helping others but also yourself.

CORNELL

Rural School Leaflet

Published Monthly by the New York State College of Agriculture at Cornell University, from September to May. L. H. Bailey, Director.

ALICE G. McCLOSKEY, Editor.

Professors G. F. WARREN and CHARLES H. TUCK, Advisors.

Vol. I. ITHACA, N. Y., SEPTEMBER, 1907. No. I.

THE POINT OF VIEW.

By L. H. Bailey.

A fundamental necessity to successful living is to be in sympathy with the nature environment in which one is placed. This sympathy is born of good knowledge of the objects and phenomena in the environment. The process of acquiring this knowledge and of arriving at this sympathy is now popularly called nature-study.

The nature-study process and point of view should be a part of the work of all schools, because schools train persons to live. Particularly should it be a part of rural schools, because the nature-environment is the controlling condition for all persons who live on the land. There is no effective living in the open country unless the mind is sensitive to the objects and phenomena of the open country; and no thoroughly good farming is possible without this same knowledge and outlook. Good farmers are good naturalists.

For many years it has been one of the purposes of the College of Agriculture in New York to point the way to this nature-sympathy; and inasmuch as this nature-sympathy is fundamental to all good farming, it was conceived that the first duty of any movement was to lend the effort to the establishing of an intelligent interest in the whole environment,—to knowledge of fields and weather, trees, birds, fish, frogs, soils, domestic animals. It would be incorrect to begin first with the specific agricultural phases of the environment, for the agricultural phase (as any other special phase) needs a foundation and a base; it is only one part of a point of view. Moreover, to begin with a discussion of the so-called "useful" or "practical" objects, as many advise, would be to teach falsely for, as these objects are only part of the environment, to single them out and neglect the other subjects would result in a partial and untrue outlook to nature; in fact, it is just this partial and prejudiced outlook that we need to correct.

In our own work, we have always had in view the agricultural aim or application. We should have been glad if there had been sufficient

nature-study sentiment to have enabled us to confine ourselves to the agricultural aim; but this sentiment had to be created or quickened, and we have tried to contribute our part toward accomplishing this result. At first it was impossible to secure much hearing for the agricultural subjects. Year by year such hearing has been more readily given, and the work has been turned in this direction as rapidly as the conditions would admit,—for it is the special mission of an agricultural college to extend the agricultural applications of nature-study. In later years the content of the work has had very direct relation to farm-life questions. The time has now come, we think, when we can devote practically all our energies to this application; and we therefore discontinue the *Junior Naturalist Monthly* and issue the CORNELL RURAL SCHOOL LEAFLET. It is the purpose of this Leaflet to aid the teacher in the rural school to work out the practical daily problem of teaching agricultural subjects.

In doing this, we merely confine ourselves to our more special field. The general nature-study outlook is fundamental, and we shall continue to emphasize it; but we feel that the appreciation of this outlook is now so well established as to allow us to specialize. The Education Department has issued syllabi for agriculture and nature-study; we desire to be useful in applying them to the conditions and needs of country life. Schools here and there are ready for agricultural work; we want to help.

In making these statements we have it in mind that the common schools do not teach trades and professions. We do not approach the subject primarily from an occupational point of view, but from the educational and spiritual; that is, the man should know his work and his environment. The mere giving of information about agricultural objects and practices can have very little good result with children. The spirit is worth more than the letter. Some of the hard and dry tracts on farming would only add one more task to the teacher and the pupil if they were introduced to the school, making the new subject in time as distasteful as arithmetic and grammar often are. In this new agricultural work we need to be exceedingly careful that we do not go too far, and that we do not lose our sense of relationships and values. Introduucing the word agriculture into the scheme of studies means very little; what is taught, and particularly how it is taught, is of the greatest moment. We hope that no country-life teaching will be so narrow as to put only technical farm subjects before the pupil.

We need also to be careful not to introduce subjects merely because practical grown-up farmers think that the subjects are useful and therefore should be taught. Farming is one thing and teaching is another. What appeals to the man may not appeal to the child. What is most useful to the man may or may not be most useful in training the mind

of a pupil in school. The teacher, as well as the farmer, must always be consulted in respect to the content and the method of teaching agricultural subjects. We must always be alert to see that the work has living interest to the pupil, rather than to grown-ups, and to be on guard that it does not become lifeless. Probably the greatest mistake that any teacher makes is in supposing that what is interesting to him is therefore interesting to his pupils.

All agricultural subjects must be taught by the nature-study method, which is: To see accurately; to reason correctly from what is seen; to establish a bond of sympathy with the object or phenomenon that is studied. One cannot see accurately unless one has the object itself. If the pupil studies corn, he should have corn in his hands and he should make his own observations and draw his own conclusions; if he studies cows, he should make his observations on cows and not on what someone has said about cows. So far as possible, all nature-study work should be conducted in the open, where the objects are. If specimens are needed, let the pupils collect them. See that observations are made on the crops in the field as well as on the specimens. Nature-study is an out-door process; the schoolroom should be merely an adjunct to the out-of-doors, rather than the out-of-doors an adjunct to the schoolroom, as it is at present.

A laboratory of living things is a necessary part of the best nature-study work. It is customary to call this laboratory a school-garden. We need to distinguish three types of school-garden: (1) The ornamented or planted grounds; this should be a part of every school enterprise, for the premises should be attractive to pupils and they should stand as an example in the community. (2) The formal plat-garden, in which a variety of plants is grown and the pupils are taught the usual handicraft; this is the prevailing kind of school-gardening. (3) The problem-garden, in which certain specific questions are to be studied, in much the spirit that problems are studied in the indoor laboratories; these are little known at present, but their number will increase as school work develops in efficiency; in rural districts, for example, such direct problems as the rust of beans, the blight of potatoes, the testing of varieties of oats, the study of species of grasses, the observation of effect of fertilizers, may well be undertaken when conditions are favorable, and it will matter very little whether the area has the ordinary "garden" appearance. In time, ample grounds will be as much a part of a school as the buildings or seats now are. Some of the school-gardening work may be done at the homes of the pupils, and in many cases this is the only kind that is now possible; but the farther removed the laboratory the less direct the teaching.

To introduce agriculture into any elementary rural school it is first necessary to have a willing teacher. The trustees should be able to settle this point. The second step is to begin to study the commonest and most available object concerning which the teacher has any kind of knowledge. The third step is to begin to connect or organize these observations into a method or system. This simple beginning made, the work ought to grow. It may or may not be necessary to organize a special class in agriculture; the geography, arithmetic, reading, manual training, nature-study and other work may be modified or redirected. It is possible to teach the state elementary syllabus in such a way as to give a good agricultural training.

In the high school, the teacher should be well trained in some special line of science; and if he has had a course in a college of agriculture he should be much better adapted to the work. Here the teaching may partake somewhat more of the laboratory method, although it is possible that our insistence on formal laboratory work in both schools and colleges has been carried too far. In the high school, a separate and special class in agriculture would better be organized; and the high school syllabus of the Education Department provides for this.

In all agricultural work in the schools of the state, the College of Agriculture desires to render all the aid it can. Correspondence is invited on the agricultural questions involved. In special cases an officer of the College may be sent to give advice on the technical agricultural phases of the teaching. Considerable literature in the publications of the College is now available and will be sent on application.

In many districts the sentiment for agricultural work in the schools will develop very slowly. Usually, however, there is one person in the community who is alive to the importance of these new questions. If this person has tact and persistence, he ought to be able to get something started. Here is an opportunity for the young farmer to exert influence and to develop leadership. He should not be impatient if results seem to come slowly. The work is new; it is best that it grow slowly and quietly and prove itself as it goes. Through the grange, reading-club, fruit-growers' society, creamery association, or other organization the sentiment may be encouraged and formulated; a teacher may also be secured who is in sympathy with making the school a real expression of the affairs of the community; the school premises may be put in order and made effective; now and then the pupils may be taken to good farms and be given instruction by the farmer himself; good farmers may be called to the schoolhouse now and then to explain how they raise potatoes or produce good milk. A very small start will grow by accretion if the persons who are interested in it do not lose heart, and in five years everyone will be astonished at the progress that has been made.

NATURE-STUDY AGRICULTURE.

By ALICE G. MCCLOSKEY.

The purpose of the Leaflets issued by the College of Agriculture at Cornell University has been to awaken an interest in nature-study and elementary agriculture. Effort was made to present the work in a simple, attractive way that the attention of teachers and pupils might be directed toward country life. During the past year the *Home Nature-Study Course,* which took up in detail the subject matter necessary for the nature-study work in the schools as founded on the syllabus of the State Educational Department, was sent to about 3,000 persons. The *Junior Naturalist Monthly* was sent to 18,966 children in New York State. Hundreds of teachers applied for these Leaflets after the fund which provided them was exhausted. During the year, 20,115 letters or compositions were received from the Junior Naturalists. These compositions covered a wide range of country life subjects.

The time has now come for more special work. The *Home Nature-Study Course* will be continued in order that teachers who are following the Nature-Study Syllabus of the Education Department may be helped in their subject matter and methods for giving instruction. The *Junior Naturalist Monthly* will be discontinued. The CORNELL RURAL SCHOOL LEAFLET will be issued for teachers, and a supplement to it for pupils. The new publication will be planned with the fundamental purpose of reaching the needs of the rural school. This does not mean, however, that it will not be helpful to teachers in village and city schools.

We shall now discontinue the forming of clubs in the schools as a necessary part of the work, although we shall be glad to continue the clubs as heretofore if the teacher desires. Instead, we shall prepare material to be handled in any way that the teacher may consider best adapted to conditions. We hope to be closely in touch with all teachers who take up this work in the grades and to help them by suggestion and personal direction as far as we are able. All lessons will be prepared by experts in the subjects presented. In each issue of the RURAL SCHOOL LEAFLET there will be four or five subjects along different lines, from which the teacher may choose one or more best adapted for study in the community. There will be lessons in connection with natural phenomena, earth study, plant study, animal life, insect life, bird life, and the like.

School-gardens will form one of the most important features of the work in nature-study agriculture. It is in the school-garden that life processes can be studied. One hour spent in actual gardening will put a child more nearly in touch with his environment than many hours spent with specimens brought into the schoolroom. Definite instruc-

tion in the management of school-gardens will be given through these Leaflets, both from the point of view of workers at Cornell and those who have established school-gardens in other parts of the country.

From time to time we shall publish accounts of men who have been successful in the different lines of farming. In every way possible the outlook to a life-work on the farm will be placed before the children in a way to dignify it and to give it its proper place in the work of the world.

In order that we may meet the needs of teachers in rural schools and others interested in country life, we must have our methods of communication well organized. We shall, therefore, ask each teacher who desires the CORNELL RURAL SCHOOL LEAFLET to fill out the blanks which we shall send, asking for the full name of the teacher and of each pupil in the class. We shall ask pupils to prepare each month a composition on some one of the subjects in the Leaflet. These compositions may be mailed to us at once, or kept until the end of the year when we shall ask to have them sent to the University. We do not want the compositions to be corrected by the teacher, and we hope that there will be no feeling that the work will be open to criticism as to scholarship. We should like any letters, compositions, or reports on the work done in the schoolroom that we may obtain from them suggestions for future work. Every thoughtful teacher realizes that the agricultural interests could be greatly increased if persons living on farms were educated along their lines of work. It is the right of every child educated in a rural community to know the possibilities that lie in intelligent work on the farm. We hope, therefore, that by means of direct communication with the University the children in New York State will be helped to realize the meaning of agricultural education, and to learn how strong and far-reaching intelligent farm work is. If every teacher in the village or rural school would encourage children in the actual study of even one subject pertaining to agriculture each month, it would accomplish much in the right direction, and would not consume a great deal of time. If the children make a report for us they will gain by two means: (1) in organizing their ideas for a letter or composition, they fix their knowledge of the subject; (2) they are unconsciously acquiring the habit of turning to specialists for information which they cannot secure from their schoolbooks.

We are hoping in the fall of 1908 to issue a bulletin giving a full report of agricultural education in ten rural schools in New York State. The material for this bulletin will be taken from the reports of work sent to us from schools in which such work has been conducted. It might be an incentive to greater industry if the children were to know

that we intend to publish this bulletin, and that every school has an opportunity to help other schools in the State by the excellence of its work. We shall offer a prize to each of the ten schools,—either a picture for the schoolroom wall or a book for the reference library, as the class shall decide.

SUGGESTIONS AS TO EQUIPMENT FOR TEACHING ELEMENTARY AGRICULTURE.

By G. F. Warren.

Very much can be done in the teaching of elementary agriculture without any special apparatus or equipment; but more can be done with equipment. This equipment need not be extensive or expensive. Some of the most essential things, as the writer has determined them in his experience, are given in the following notes.

1. Materials and equipment for teaching agriculture in grades below the high school.

Very little equipment is necessary, but a number of simple pieces of apparatus are desirable. One or more hand lenses of rather high magnifying power should be procured. Bausch and Lomb Optical Company, Rochester, New York, sell such a lens, No. 6, for 75 cents. Their tripod lens No. QR., costs 30 cents, but I prefer the former. It is also desirable but not so necessary that the school have a cheap balance that will weigh to half ounces or centigrams. Such a balance may be secured for about $5. Spring balances, bottles, jars and other materials, may be brought from home by the pupils when needed.

Schoolroom.

Perhaps the most important equipment is a room in which plants can be kept growing for experiments and other laboratory work. If the room freezes so that plants cannot be grown in winter, this type of work will need to be done in the fall and spring.

School-garden.

It is also very desirable that there be some open area in the school yard for a school-garden. In rural districts this should not be patterned after the city school-garden, which is the one that is described in the common articles on school-gardens. Children in rural districts have learned a great deal at home and should be given a much more advanced type of school-garden work. The rural school-garden may well become a place for carrying out simple experiments in such questions as the depth

of planting seeds, effects of different amounts of cultivation, and the like. If the garden can be kept up during the summer, a great number of experiments can be performed. Different fertilizers may be used. Alfalfa, vetch, soybeans and others of the newer crops may be grown. In many cases experiments may be conducted by farmers adjacent to the school grounds and may be studied by pupils and teacher.

The best place for pupils' private gardens is at home, where they can be under the constant eye of the gardener. Efforts put forth in encouragement of home gardens nearly always bring good results. It is not necessary that such a garden be for vegetables or flowers. Pupils, particularly the older ones, may grow corn, potatoes, alfalfa, and other crops.

School-garden work may be connected with exhibits at the county fairs with prizes.

References.

Write to the Secretary of Agriculture at Washington, D. C., for one copy of each of the Farmers' Bulletins and the index to them. There are about 275 of these bulletins, each one dealing with a specific topic such as alfalfa, corn, modern conveniences in the farm-home, etc. They will be sent free. These may be punched and tied into volumes with shoe-strings. Manila paper makes a good cover. These bulletins make a good reference library in agriculture. Many of the numbers are suitable for supplementary reading. If they are in the schoolroom, pupils will get much benefit by voluntary reading.

Also ask the Secretary of Agriculture for Bulletin 186 of the Office of Experiment Stations, "Exercises in Elementary Agriculture." This contains detailed directions for carrying out such exercises in rural schools.

Write your Congressman asking him to send your school library one copy each of the Yearbooks of the Department of Agriculture that he has for distribution. These are interesting volumes and well illustrated.

Ask the New York Agricultural Experiment Station at Geneva to send you one copy of each of its bulletins and reports that are available for your library.

Write to the New York State College of Agriculture at Cornell University, Ithaca, asking for one copy each of its bulletins and reports that are available; also for one copy each of the Farmers' and Farmers' Wives' Reading-Course Bulletins.

Many of these bulletins, particularly the Farmers' Reading-Course Bulletins, can be used as a textbook. Choose a few of these that you expect to use and ask for enough to supply the class.

The teacher should also receive the nature-study publications of the College of Agriculture. The handsome volume of "Cornell Nature-

Study Leaflets," of 600 pages, is sent to teachers in the State who remit 30 cents to cover cost of postage and handling.

Textbooks.

No textbooks are necessary. If the teacher desires to procure some book, one or two of the following will be of value. Reference books may be selected from the high school list:

Agriculture for Beginners, Burkett, Stephens and Hill; Ginn & Co.

New Elementary Agriculture, Bessey and others; University Publishing Co., Lincoln, Nebraska.

First Principles of Agriculture, Goff & Mayne; American Book Co.

Principles of Agriculture, Bailey; Macmillan Co.

Soils and How to Treat Them, Brooks;

Manures, Fertilizers, and Farm Crops, Brooks;

Animal Husbandry, Brooks; King Richardson Co., Springfield, Mass.

Agriculture Through the Laboratory and School Garden, Jackson & Dougherty; Orange Judd Co.

2. *Materials and equipment for teaching agriculture in high schools.*

If it is desired to teach agriculture before botany and chemistry are taught, the suggestions given for grades below the high school apply, particularly such exercises as those outlined in Office of Experiment Stations Bulletin 186.

It is usually desirable that botany and chemistry precede agriculture in the high school, provided the school can teach both of these subjects. One cannot go very deeply into agricultural study without the aid of these subjects. If botany can be taught in the ninth year and chemistry in the tenth or eleventh, students will be ready for good solid agricultural study in the eleventh or twelfth year. It would be possible to give such an agricultural course in the same year with chemistry, if it seems best.

Equipment.

The microscopes, balances, thermometers, test tubes, crucibles, etc., that are used in teaching botany and chemistry will nearly equip the agricultural laboratory. There should also be a supply of flower-pots, Mason fruit-jars, and other materials that can be procured as the class progresses.

Every school that is situated in a dairy region should have also a Babcock milk-testing outfit. D. H. Burrell & Co., Little Falls, N. Y.,

advertise such an outfit, the "Facile Jr. four bottle milk and cream testing outfit," complete with directions for use for $5.50. A less desirable outfit can be secured for $4. After students have learned to use the outfit, they can test milk for farmers, and so bring the school into touch with the practical affairs of the district.

Schools should also have a cabinet or cupboard in which are placed bottles containing samples of seeds, fertilizers, soils, spraying materials, cattle feeds.

References.

All of the references mentioned for elementary schools should be secured.

The Office of Experiment Stations, Washington, D. C., is publishing a set of exercises in agronomy for high schools that will soon be available. This aims to show just how to use available bulletins as a textbook in high schools and gives detailed directions for definite laboratory exercises.

The State Education Department at Albany is issuing a somewhat similar but more elementary set of exercises. It is thought that by the use of these two bulletins the teacher will be able to conduct systematic work.

Reference Books.

There are few if any textbooks designed for high school students who have studied botany and chemistry. It is desirable to have as many as possible of the following reference books:

1. Cereals in America, Hunt.
2. Forage and Fiber Plants in America, Hunt.
3. Physics of Agriculture, King.
4. Chemistry of Plant and Animal Life, Snyder.
5. Milk and Its Products, Wing.
6. The Horse, Roberts.
7. Animal Husbandry, Brooks.
8. The Fertility of the Land, Roberts.
9. The Farmstead, Roberts.
10. The Principles of Fruit-Growing, Bailey.
11. The Farmers' Handbook, Woll.
12. The Practical Garden-Book, Bailey.
13. Fertilizers, Voorhees.
14. Corn Plants, Sargent.
15. The Soil, King.
16. Experiments with Plants, Osterhout.

The publishers are:

1 and 2. Orange Judd Co., New York.
3. F. H. King, Madison, Wisconsin.
4. Chemical Publishing Co., Easton, Pa.
7. King Richardson Co., Springfield, Mass.
11. John Wiley, New York.
14. Houghton, Mifflin & Co., New York.
All others, the Macmillan Co., New York.

Academies, normal schools, high schools, wishing to introduce agriculture are asked to write to the College of Agriculture, stating their conditions as definitely as possible. All such letters will receive careful attention and, if possible, a personal visit to the school will be arranged during the year.

PUBLICATIONS OF COLLEGE OF AGRICULTURE

Now available for distribution as long as the supply lasts.

1. Home Nature-Study Course.

Vol. I, No. 1, Oct.–Nov., 1904.
No. 4, Apr.–May, 1905.
Vol. II, No. 1, Oct.–Nov., 1905.
No. 2, Dec., 1905–Jan., 1906.
No. 3, Feb.–Mar., 1906.
No. 4, Apr.–May, 1906.
Vol. III, No. 1, Oct.–Nov., 1906.
No. 2, Dec., 1906–Jan., 1907.
No. 3, Feb.–Mar., 1907.
No. 4, Apr.–May, 1907.

2. Issues of Junior Naturalist Monthly.

Vol. VI, No. 4, Jan., 1904.
No 5, Feb. 1904.
No. 6, Mar., 1904.
No. 7, Apr., 1904.
Vol. I, No. 4, Jan., 1905.
No. 5, Feb. 1905.
No. 6, Mar., 1905.
No. 7 Apr., 1905.
Vol. I, No. 8, May, 1905.
Vol. II, No. 3, Dec., 1905.
No. 4, Jan., 1906.
No. 5, Feb., 1906.
No. 6, Mar., 1906.
Vol. III, No 3, Dec., 1906.
No. 4, Jan , 1907.

3. Bulletins of the Farmers' Reading Course.

Series I. THE SOIL AND THE PLANT. The Bulletins in this series are: (1) The Soil, What it is; (2) Tillage and Under-Drainage, with Supplement; (3) The Fertility of the Soil, with Supplement; (4) How the Plant gets its Food from the Soil; (5) How the Plant gets its Food from the Air.

Series II. STOCK-FEEDING. The Bulletins in this series are: (6) Balanced Rations for Stock; (7) The Computing of Balanced Rations; (8) Sample Rations for Milch Cows; (9) Soiling Crops and Silage and Supplement; (10) Pastures and Meadows.

Series III. ORCHARDING. The Bulletins in this Series are: (11) How a Fruit Tree Grows; (12) Planting the Orchard; (13) Tilling and Fertilizing the Orchard; (14) Pruning and Spraying Fruit-Trees, and Supplement; (15) Picking, Storing and Marketing Fruit.

Series IV. POULTRY. The Bulletins in this series are: (16) Building Poultry Houses, and Supplement; (17) Feeding of Laying Hens; (18) Rations for Poultry; (19) Raising Chickens; (20) Marketing Poultry Products.

Series V. DAIRYING. The Bulletins in this series are: (21) The care of Milk; (22) The Composition of Milk; (23) The Construction of Sanitary Dairy Stables; (24) Farm Butter-Making; (25) The Dairy Herd.

Series VI. FARM BUILDINGS AND YARDS. The Bulletins in this series are: (26) Tasteful Farm Buildings; (27) Tasteful Farm Yards; (28) The Plan of the Farmhouse; (29) Water Supplies for Farm Residences; (30) Barns and Out-Buildings.

4. Bulletins of the Farmers' Wives Reading-Course.

Series I. FARMHOUSE AND GARDEN. (1) Saving Steps; (2) Decoration in the Farm Home; (3) Practical Housekeeping; (4) The Kitchen-Garden; (5) The Flower-Garden.

Series II. THE FARM FAMILY. (6) The Rural School and the Farm Home; (7) Boys and Girls on the Farm; (8) Reading in the Farm Home; (9) Home Industries; (10) Household and Garden Pests.

Series III. SANITATION AND FOOD. (11) Home Sanitation; (12) Germ Life; (13) Human Nutrition; (14) Food for the Farm Family; (15) Saving Strength; (16) Programs for Evenings with Farmers' Wives Clubs.

Series IV. THE FARM TABLE. (17) Flour and Bread; (18) Dust as related to Food; (19) The Selection of Food; (20) Canning and Preserving.

Series V. SUGGESTIONS ON FARMERS' READING COURSE BULLETINS. (21 to 25).

5. *Bulletins of the Experiment Station.*

93 The Cigar-Case Bearer.
121 Suggestions for planting Shrubbery.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
134 Strawberries under glass.
135 Forage Crops.
136 Chrysanthemums.
137 Agricultural Extension Work, Sketch of its Origin and Progress.
139 Third Report upon Japanese Plums.
140 Second Report upon Potato Culture.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling Moth.
143 Sugar Beet Investigations.
144 Suggestions on Spraying and on the San José Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work.
147 Fourth Report upon Chrysanthemums.
148 Quince Curculio.
150 Tuberculosis in Cattle and Its Control.
151 Gravity or Dilution Separators.
152 Studies in Milk Secretions.
153 Impressions of Fruit-Growing Industries.
154 Table for Computing Rations for Farm Animals.
155 Second Report on the San José Scale.
157 Grape-vine Flea-beetle.
158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
162 The Period of Gestation in Cows.
163 Three Important Fungous Diseases of the Sugar Beet.
164 Peach Leaf-Curl.
165 Ropiness in Milk and Cream.
166 Sugar Beet Investigations for 1898.
168 Studies and Illustrations of Mushrooms; II.
170 Tent Caterpillars.
171 Concerning Patents on Gravity or Dilution Separators.
172 The Cherry Fruit-Fly; A New Cherry Pest.
176 The Peach-Tree Borer.
180 The Prevention of Peach Leaf-Curl.
182 Sugar Beet Investigations for 1899.
183 Sugar Beet Pulp as Food for Cows.
184 The Grape Root-Worm; New Grape Pest in New York.
185 The Common European Praying Mantis; A New Beneficial Insect in America.
186 The Sterile Fungus Rhizoctonia.
187 The Palmer Worm.
189 Oswego Strawberries.
190 Three Unusual Strawberry Pests and a Green house Pest.
192 Further Experiments against the Peach-Tree Borer.
193 Shade Trees and Timber Destroying Fungi
195 Further Observations upon the Ropiness in Milk and Cream.
196 Fourth Report on Potato Culture.
198 Orchard Cover Crops.
199 Separator Skimmed Milk as Food for Pigs.
206 Muskmelons.
206 Sixth Report of Extension Work.
207 Pink Rot an Attendant of Apple Scab.
208 The Grape Root-Worm.
210 Commercial Bean Growing in New York.
212 Cost of Producing Eggs. Second Report.
216 Spraying for Wild Mustard and the Dust Spray.
219 Diseases of Ginseng.
220 Skimmed Milk for Pigs.
221 Alfalfa in New York.
222 Attempt to Increase the Fat in Milk by Means of Liberal Feeding.
225 Bovine Tuberculosis.
227 Cultivation oj Mushrooms by Amateurs.
228 Potato Growing in New York.
231 Forcing of Strawberries, Tomatoes, Cucumbers and Melons.
232 Influence of Fertilizers Upon the Yield of Timothy Hay.
233 Two New Shade-Tree Pests.
234 The Bronze Birch Borer.
235 Cooperative Spraying Experiments.
237 Alfalfa—A Report of Progress.
238 Buckwheat.
239 Some Diseases of Beans.
240 The Influence of Mushrooms on the Growth of Some Plants.
241 Second Report on the Influence of Fertilizers on the Yield of Timothy Hay.
242 Cabbages for Stock Feeding.
243 Root Crops for Stock Feeding.
244 Culture and Varieties of Roots for Stock Feeding.
245 Spray Calendar.
246 A Gasolene-Heated Colony Brooder-House.
247 The Importance of Nitrogen in the Growth of Plants.
248 New Poultry Appliances.

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